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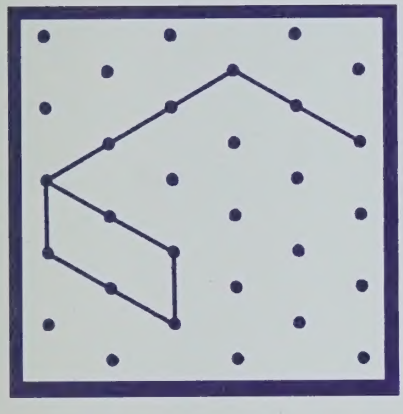
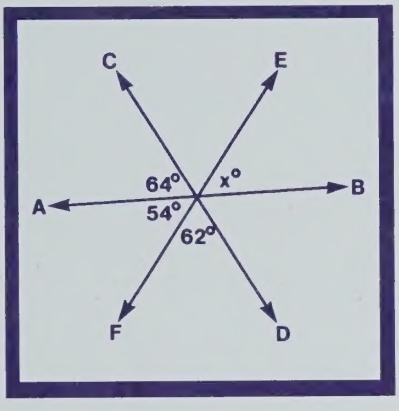
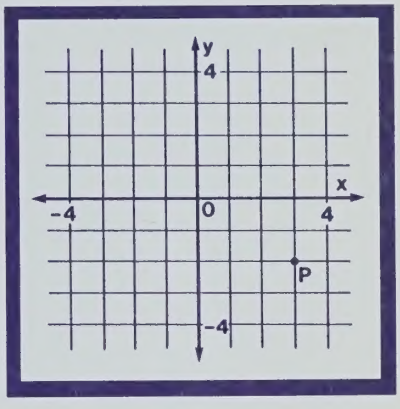
MATHEMATICS

Grade 8

A REPORT FOR EDUCATORS







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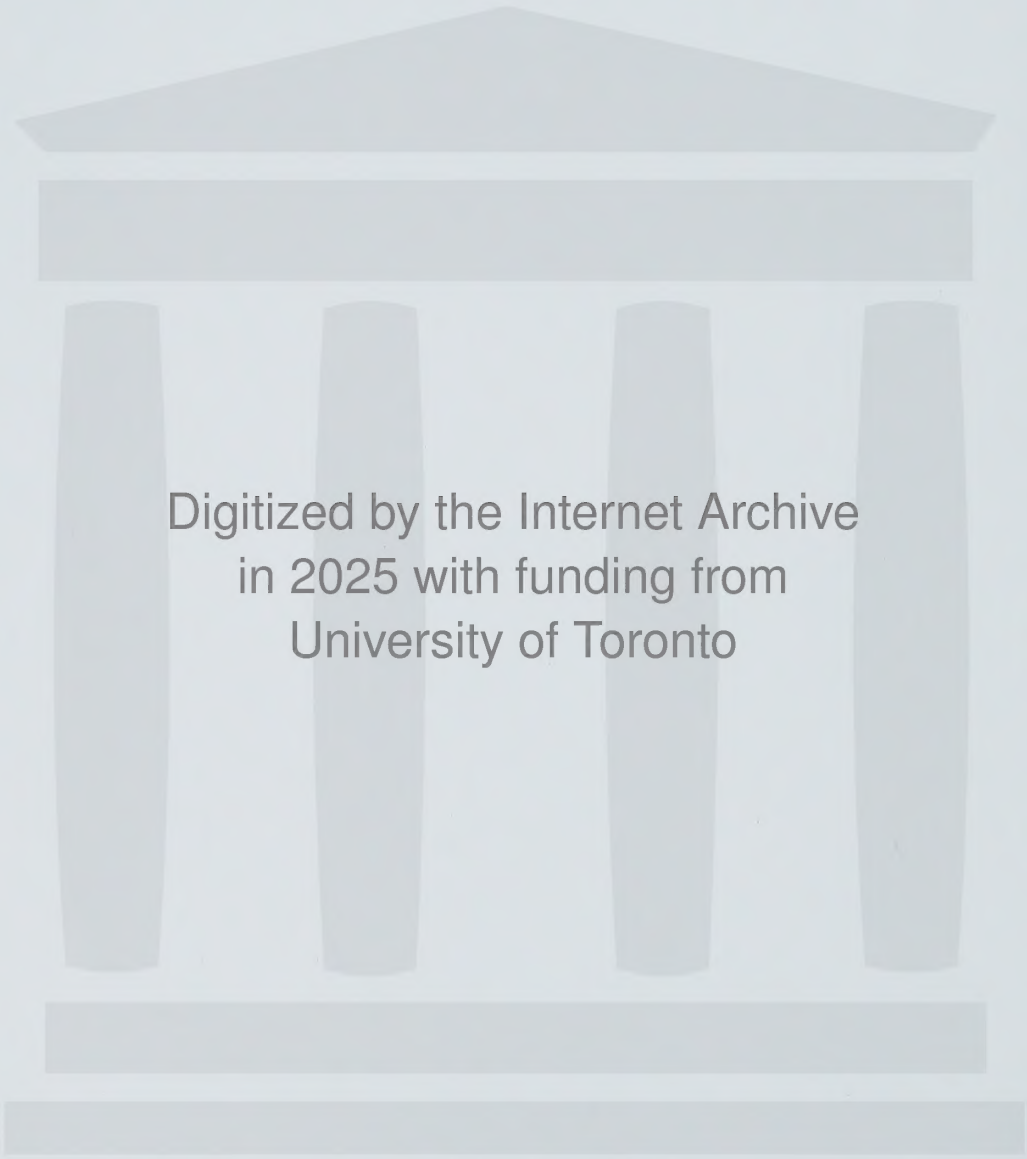
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Grade 8
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This review would not have been possible without the dedication shown by the many individuals who worked on various committees. Members of the main review committees are identified in Appendix G. We also want to thank the Lakehead Board of Education and the Metropolitan Separate School Board for their co-operation in making it possible to have photographs taken in their classrooms.

Executive Summary

Overview

The provincial review of mathematics for Grade 8 is part of an ongoing program of provincial reviews instituted by the Ministry of Education. These reviews are the primary means by which the ministry carries out its commitment to monitor education in the Province of Ontario and inform the public about the performance of the educational system.

In order to obtain a direct indication of how well Grade 8 students have achieved the goals of the mathematics program, the Grade 8 students in 101 English-language schools answered multiple-choice and open-ended questions in numerical methods and algebra, measurement and geometry, use of calculators, mental computation, and applying problem-solving strategies to process problems.

Questionnaires answered by principals, teachers, and students provided information on teaching practices and student attitudes.

Student Performance on Mathematics Tasks

Grade 8 students achieved at levels that were judged to be satisfactory or better in half of the topics in the course; achievement was rated as *strong* in three topics, *satisfactory* to *strong* in one topic, *satisfactory* in five topics, *marginal* to *satisfactory* in one topic, *marginal* in five topics, and *weak* in two topics.

Achievement was *strong* in the topics of three-dimensional geometry and organization and representation of data; it was *satisfactory* to *strong* in whole numbers and decimals. Achievement was *satisfactory* in factors, powers, and square roots; ratio and rate; variables, formulas, and equations; properties of plane figures; and observation activities. Achievement was rated as *marginal* to *satisfactory* in geometric transformations. Achievement in the following topics was rated as *marginal* or *weak*: fractions, per cent, integers, measurement, geometric constructions, process problems, and mental computation.

Student Attitudes

Most students expressed positive attitudes towards mathematics. More than 80 per cent thought that mathematics was important for employment, that it was of equal importance for boys and girls, and that it was helpful to them outside of school. Sixty-three per cent of students felt that they were good in mathematics, and 20 per cent felt that mathematics was difficult. Sixty-seven per cent of students liked mathematics. When given a difficult problem, most students attempted a variety of approaches to reach a solution; few students gave up before reaching a solution.

Classroom Activities and Classroom Practices

The most commonly used methods of instruction were chalkboard or projector presentations to the whole class and having students work individually on assignments. Teacher demonstrations with concrete materials were used for an average of 15 per cent of the class time.

Calculators were often used in 33 per cent of classrooms and occasionally used in 40 per cent of classrooms. Sixty-seven per cent of teachers reported that students had access to computers. When computers were available, teachers most frequently encouraged students to use them to practise new concepts, to learn new concepts and skills, and as an aid in doing projects.

Most students reported that they frequently worked on mathematics alone and that their teacher frequently taught mathematics to the whole class. More than half of the students never did projects in mathematics, and most students never used a computer in mathematics class.

Fifty-one per cent of students had computers at home, but only 9 per cent used them for mathematics school work.

Twenty-six per cent of students did more than one hour of mathematics homework each week, 46 per cent did one-half to one hour, 23 per cent did less than half an hour, and 5 per cent did no mathematics homework.

Teachers reported that students had the opportunity to learn the course content required to answer most of the questions in the Student Assessment Booklets. Opportunity to learn was highest for numerical methods and algebra and lowest for measurement and geometry.

It is hoped that this report will encourage discussion about mathematics in Ontario schools. Ontario educators should now take steps to:

- maintain the strengths that were identified by this review of the Grade 8 mathematics program;
- recommend and implement procedures that will lead to improvement in areas where weaknesses were identified.

1. Purpose of the Review

The provincial review of mathematics for Grade 8 is part of an ongoing program of provincial reviews conducted by the Ministry of Education. These reviews are the primary means by which the ministry carries out its commitment to monitor education in Ontario and inform the public about the performance of the educational system. They are based on Ministry of Education curriculum guidelines and provide information about program implementation and student achievement. The main purposes of the reviews are to:

- determine the effectiveness of curricula and the level of student achievement at the school, board, and provincial levels;
- provide Ontario educators with information that may be used to make decisions for modifying and improving programs and improving levels of student achievement;
- establish baseline data on both program effectiveness and student achievement against which information generated by future reviews can be compared in order to determine progress;
- provide instruments and procedures that can be used in the future by school boards.

The provincial review of mathematics for Grade 8 was carried out for two main reasons: first, to generate a profile of the nature of mathematics instruction in the Grade 8 course in Ontario; and, second, to determine how well students enrolled in this course are achieving the goals of the mathematics program.

The profile of mathematics instruction describes some of the characteristics of students enrolled in mathematics in Grade 8, their teachers, and the mathematics activities that occur in their classes. It also compares students' achievement on specific tasks with the performance expectations of parents, trustees, and educators.

Relating the profile to our current knowledge of the nature of mathematics and to the Ministry of Education's policy and guidelines on mathematics instruction will assist in identifying the most appropriate directions for mathematics instruction in Grade 8 courses to follow during the 1990s. The identification of these directions can be facilitated by an analysis of the responses to the Principal Questionnaire, the Teacher Questionnaire, the Student Questionnaire, and the Student Assessment Booklets that were administered as part of this review.

This report presents in detail the results of the provincial review of mathematics for Grade 8 conducted in the spring of 1990. A summary document, *Mathematics, Grade 8: A Report Card for Ontario,* has also been prepared. Parallel reports based on data from French-language schools are also available.

2. Mathematics in Ontario Schools

Mathematics is an essential skill for literate citizens because it is required in all areas of life, including the home and the marketplace as well as the school. It includes the study of patterns, the creation and application of abstract systems, and the use of logical arguments. For these reasons, the study of mathematics is an integral part of the education of all students. It should help them appreciate the contribution that mathematics has made to the development of civilization, as well as prepare them for postsecondary education and for future careers.

As part of its province-wide responsibility, the Ministry of Education, Ontario, establishes goals, policies, and specific expectations through its curriculum guidelines. The provincial curriculum policy for Ontario programs in the Intermediate and Senior Divisions is outlined in *Ontario Schools, Intermediate and Senior Divisions (Grades 7-12/OACs): Program and Diploma Requirements, 1989*, rev. ed. *(OSIS)*. The specific expectations for Grade 8 mathematics are provided in the curriculum guideline *Mathematics, Intermediate and Senior Divisions, 1985*.

While the ministry sets goals, policies, and specific expectations, it is the responsibility of local school boards to formulate programs that are within the rationale of the provincial policy and, at the same time, reflect local needs and priorities. Teachers, working both individually and as a group under the leadership of the department head, have the task of planning and delivering classroom programs that are specifically adapted to the students for whom they are responsible. This task includes the selection of appropriate teaching strategies, resources, and learning activities.

In the past, research has made significant contributions to the development and implementation of mathematics programs in Ontario's schools. It is expected that the results of this provincial review will be similarly beneficial.

3. Description of the Measures and Samples for the Provincial Review

3.1 The Instruments

This provincial review used the following instruments to create a multifaceted profile of the mathematics experience of Grade 8 students: Principal Questionnaire, Teacher Questionnaire, Opportunity-to-Learn Form, Student Questionnaire (including calculator questions), Student Assessment Booklets, Observation Booklets, and Mental-Computation Questions. All of these instruments are included in a separate publication entitled *Mathematics, Grade 8: Review Instruments*. As well, planning documents were submitted to the ministry for review.

- The **Principal Questionnaire** was used to collect information on the school environment and curriculum-management practices in the school. The questionnaire covered the following areas: the number of students enrolled in and the time allocated for mathematics instruction, the community served, the procedure for reviewing the mathematics programs, and the extent of professional activities in mathematics education.

- The **Teacher Questionnaire** was used to collect information on teaching experience, personal and professional backgrounds of teachers, resources, teaching methods, and evaluation procedures.

- The **Opportunity-to-Learn Form** was used to collect information as to whether or not students had been taught the concepts and skills necessary to answer the questions in the Student Assessment Booklets.

- The **Student Questionnaire** provided information about the background and attitudes of Grade 8 students. Students answered questions about themselves and some of their activities outside of school, their attitudes towards school and mathematics, and what they did during mathematics class. Part of this questionnaire consisted of calculator questions which assessed student achievement on skills and concepts with the aid of a calculator.

- **Student Assessment Booklets** were used to measure student achievement in mathematics. Each of five different booklets contained forty questions related to the non-optional topics of the Grade 8 mathematics program. Most of these were multiple-choice questions, but five questions in each of four of the booklets required a written response. Some of these latter questions required students to supply a numerical response, some required that students undertake the completion of a diagram, some required a geometric construction, and others required that students undertake the solution of a problem. In the fifth booklet, all forty questions were multiple-choice.

- The **Observation Booklets** were used by the teacher to assess, through observation, students' ability to manipulate materials, to use the calculator, to construct graphs, to estimate quantities and measures, and to take measurements. Each of the six booklets contained instructions for the teacher to have the students perform tasks. The teacher recorded a description of each student's performance.

- **Mental-Computation Questions**. Student achievement was also measured through the use of mental-computation questions presented orally. The teacher read a question, then wrote down the numbers on the chalkboard or the overhead projector, and students were required to solve the problem mentally. They were not allowed to work out their answers on paper or to use a calculator.

The following objectives of the mathematics program in Grade 8 were assessed in this provincial review. These objectives were taken from *Mathematics, Intermediate and Senior Divisions, 1985.*

- **Numerical Methods and Algebra**

  — *Calculator Skills*

    - identifying the appropriate and inappropriate uses of calculators
    - clearing the display of a calculator; correcting entry errors
    - using calculators to add, subtract, multiply, and divide
    - using subtotals and memory for adding, subtracting, multiplying, and dividing
    - ordering operations to obtain a desired result with calculators
    - selecting from calculator displays the number of decimal places appropriate to the calculation

- using rounding and estimation
- checking the reasonableness of an answer obtained with calculators

— *Whole Numbers and Decimals*

- identifying whole-number place values to millions
- identifying decimal place values to thousandths
- consolidating and applying the addition, subtraction, multiplication, and division of whole numbers and decimals without calculators (Note: These operations with whole numbers and decimals using calculators are included in the calculator section of the Student Questionnaire.)
- multiplying and dividing a number mentally by 10, 100, and 1000
- evaluating numerical expressions using rules for the order of operations
- applying estimation, rounding, and reasonableness of results in calculations, in problem solving, and in applications

— *Factors, Powers, and Square Roots*

- identifying and applying divisibility tests for 2, 3, 5, 9, and 10
- identifying the factors of a number; identifying prime numbers and composite numbers
- determining factors of a composite number up to 100 without calculators
- writing repeated factors in exponential form; writing numbers in exponential form as repeated factors
- identifying the squares of whole numbers from 1 to 10; identifying the square roots of perfect squares from 1 to 100

— *Fractions*

- adding, subtracting, multiplying, and dividing fractions with simple denominators (up to three operations per question); applications
- converting fractions and mixed numbers to decimals, with and without calculators
- demonstrating that the decimal form of a fraction either terminates or repeats
- converting terminating decimals to fractions

— *Ratio and Rate*

- identifying a ratio as the comparison of two or more quantities in the same units
- expressing two-termed ratios in fractional form; distinguishing between fractions and two-termed ratios in fractional form
- stating equivalent ratios involving two or three terms; simple applications of equivalent ratios
- identifying a rate of comparison of two quantities in different units; simple applications of rates in problem solving

— *Per Cent*

- expressing per cents (including per cents greater than one hundred or less than one) as decimals, as fractions, or as ratios
- expressing decimals, fractions, and ratios as per cents
- applying per cents to practical problems such as sales tax, simple interest, commission, and discount

— *Integers*

- identifying the use of integers in practical examples
- locating integers on the number line; ordering integers
- locating ordered pairs of integers in the plane
- adding and subtracting one-digit and two-digit integers without calculators

— *Organization and Representation of Data*

- representing data by bar graphs and broken-line graphs
- reading and interpreting bar graphs and broken-line graphs
- reading and interpreting pictographs in which one element represents more than one object
- representing data by circle graphs
- reading and interpreting circle graphs

— *Variables, Formulas, and Equations*

- evaluating algebraic expressions by substitution without calculators (Note: This skill with calculators is included in the calculator section of the Student Questionnaire.)
- developing simple formulas by generalizing from numerical cases

- translating word phrases and statements to algebraic expressions or equations
- interpreting algebraic expressions and equations related to applications as word phrases or statements
- solving linear equations in one variable by informal methods
- substituting in formulas and solving the resulting linear equations without calculators

■ **Measurement and Geometry**

— *Measurement*

- consolidating conversions among commonly used units within the metric system
- calculating in numerical cases the perimeter of figures bounded by line segments
- calculating in numerical cases the area of irregular figures that can be decomposed into rectangles
- calculating the perimeter and area of rectangles, triangles, and parallelograms using appropriate formulas; applications
- stating and applying formulas for the circumference and area of a circle
- calculating the surface area of rectangular and triangular prisms by relating it to faces or nets
- stating and applying a formula for the volume of a rectangular prism
- calculating the volume of non-rectangular prisms

— *Constructions*

- constructing congruent segments and angles, perpendicular lines, parallel lines, perpendicular bisectors, and angle bisectors
- testing for perpendicular lines
- testing for parallel lines
- constructing 90° and 45° angles without a protractor
- constructing triangles and quadrilaterals from given information
- constructing a triangle congruent to a given triangle; investigating the conditions for congruent triangles

— *Properties of Plane Figures*

- identifying through investigation the equal- and supplementary-angle properties of intersecting lines and parallel lines
- identifying through investigation the equal-angle properties of isosceles and equilateral triangles
- identifying through investigation the sum-of-the-angles property of a triangle
- applying the above properties in numerical cases
- investigating the Pythagorean theorem; numerical applications

— *Three-Dimensional Geometry*

- classifying pyramids and prisms by their bases
- recognizing three-dimensional objects from sketches (perspective; front, side, and top views)
- sketching simple three-dimensional objects (e.g., rectangular solids, pyramids, cylinders, and cones)

— *Transformations*

- identifying the image of a figure under translation, reflection, and rotation, using the basic property of each transformation; drawing such images
- identifying the transformation relating two congruent figures; drawing the translation arrow, reflection line, or rotation centre and angle
- drawing enlargements and reductions; making and using scale drawings; concept of scale factor (scale ratio); applications such as maps and floor plans
- identifying the properties of similar figures (shape, sides, angles, and area)

■ **Problem Solving**

Developing the ability to solve problems is a major goal of mathematics education. Problem solving is not exclusively the domain of mathematics; it is an integral part of all subjects and of everyday life.

There are two major types of problems:

1. Those for which a strategy is evident immediately. Difficulties in solution are related to one's ability to carry out the strategy correctly.
2. Those for which a strategy is not immediately evident. Difficulties in solution are initially related to choosing an appropriate strategy.

This review contains both types of problems. However, the last two questions in four of the Student Assessment Booklets are of the second type and are assessed not only for the answer given but also for the process used. For reporting purposes, only the second type of problem was treated as a separate topic. These problems are called **process problems**.

The following categories were used to classify questions according to the level of thought required:

- *recognition/recall*: the recognition or recall of definitions, concepts, formulas, or algorithms
- *comprehension*: the use of a concept, formula, or algorithm in a routine way requiring little analysis
- *application*: the use of a concept, formula, or algorithm in a problem requiring some analysis; the solving of a non-routine problem which requires the choice of a strategy as well as analysis

3.2 Development and Administration of Instruments

The assessment booklets and questionnaires used in the provincial review of mathematics for Grade 8 were developed by a team of educational experts in the subject of mathematics who collaborated in selecting the areas to be examined and composing the individual questions. Once the booklets were completed, they were presented to an independent panel of consultants, who evaluated their overall validity; that is, the consultants determined whether the questions evaluated students' skills in mathematics at the appropriate level – Grade 8 – in the designated areas. Following the meeting of the evaluation panel, the questions were pilot-tested to ensure that they were appropriate for Grade 8 students and free of flaws.

The Student Assessment Booklets were distributed to participating schools for administration in May 1990. The five different booklets were randomly distributed to students in each class so that approximately equal numbers of students within each class would be responding to each booklet. Although a time estimate for completion of the booklet was given, teachers were advised to allow students sufficient time to answer all questions. Students were excluded from the assessment only if they were enrolled in an English-as-a-second-language or a special-education program.

Questionnaires were answered by principals, teachers, and students during April 1990. When students completed the questionnaire, they also answered a number of questions for which they were allowed to use calculators. The mental-computation questions were presented orally by the teacher. All students answered the same questions. Each teacher randomly selected two students to perform the tasks in each of the six observation booklets.

Students' answers to questions requiring a written response were marked by their classroom teachers. The scoring guide for these questions is given in *Mathematics, Grade 8: Review Instruments.*

3.3 Interpretation of Results

An interpretation panel consisting of teachers, administrators, university professors, trustees, and parents reviewed the test questions and results to establish standards and make judgements about student achievement. Panel members are listed in Appendix G.

Establishing Standards

The first task of the panel was to decide what constituted acceptable and desirable levels of performance on the test questions. This determination was based on the members' familiarity with skill levels of Grade 8 mathematics students, and with the Ontario curriculum. When setting these standards, the panel members had no knowledge of students' actual performance levels in responding to the test questions.

To establish these standards, panel members reviewed each of the test questions prior to the tabulation of the results. Members were then asked to determine for each question the percentage of correct answers that would constitute (a) an acceptable level of performance and (b) a desirable level of performance. Acceptable performance was defined as the level of achievement below which a real weakness was indicated.

Desirable performance was defined as a higher level of achievement that would indicate a strength. The desirable level was not to be considered an ideal level of achievement.

The panel carried out its task in three stages.

- **Stage 1:** Each panel member was instructed to set acceptable and desirable levels of performance for all questions in the assessment booklets, for the calculator questions, for the mental-computation questions, and for the observation booklets.

- **Stage 2:** Panel members met in small groups to compare their individual ratings, discuss their rationales for them, and arrive at a small-group consensus on the levels of performance for each question.

- **Stage 3:** Once the small groups had arrived at a group consensus, panel members met as one large group. The small-group ratings were shared, and a large-group consensus for acceptable and desirable levels of performance for all questions was established.

This process determined the standards by which assessment outcomes could be judged and rated.

Making Judgements

The mandate of the panel at the second phase of the interpretation process was to create overall ratings of student achievement by examining the standards established during the first phase and the scores achieved by students on each of the questions in the Student Assessment Booklets. For each question, overall student achievement was rated on the following scale:

5 – superior:	This level indicated outstanding student performance, showing a definite strength in the program.
4 – strong:	This level indicated strong student performance and is to be expected if the program has been implemented effectively.

3 – satisfactory: This level indicated acceptable student performance and is to be expected if the program has been implemented adequately.

2 – marginal: This level indicated student performance that is slightly less than satisfactory, and points out an area of the program that needs improvement but is not a major weakness.

1 – weak: This level indicated student performance that is definitely unsatisfactory, and points out a major weakness in the program.

To establish ratings on the five-point scale, the panellists examined each question, the percentage correct on that question, and the acceptable and desirable levels set during the first phase. Once again, a multistage process was used to arrive at a group consensus.

- **Stage 1:** Each panellist assigned a performance rating to each question in the assessment booklets.

- **Stage 2:** The panellists met in small groups to share and discuss their individual ratings and to arrive at a small-group consensus on the rating for each question.

- **Stage 3:** Once the small groups had arrived at a consensus for the ratings on all questions, they met as a large group to arrive at a whole-group consensus for each question.

- **Stage 4:** Following the discussion and establishment of consensus on each question, the whole group was presented with the distribution of question ratings within each of the curriculum areas examined. On the basis of this distribution, the whole group arrived at a single descriptor of student performance for each curriculum area.

The panel generated considerable discussion and debate before a consensus emerged. This discussion assisted in identifying the strengths and weaknesses discussed in "8. Student Achievement".

3.4 Provincial Review Participants

Reviews of mathematics were conducted in both English and French schools. In each case two different groups were involved in the review: those chosen to constitute the provincial sample and those who opted to participate in board reviews. The present report pertains only to the English-language provincial sample. The results of the French review may be found in *Les mathématiques, 8e année : rapport à l'intention des éducateurs et des éducatrices.*

A sample of 101 schools was randomly selected from the entire population of English-language schools in Ontario offering Grade 8 mathematics. The data collected from this sample are representative of the entire Grade 8 population. Students in English-as-a-second-language programs and students identified as exceptional by an Identification, Placement, and Review Committee did not participate. The number of respondents for each instrument is shown in Table 1. For Student Assessment Booklets, the number of respondents represents the total number of students for all booklets. Since some students answered more than one booklet, this number does not equal that for booklets reported in Appendix D.

Table 1
Number of Respondents

Instrument	*Respondents*
Principal Questionnaire	98
Teacher Questionnaire	170
Opportunity-to-Learn Form	175
Student Questionnaire	4849
Student Assessment Booklets	4649
Mental-Computation Questions	4864
Calculator Questions	4848
Observation Booklets	1600

Response rates were 97 per cent for the Principal Questionnaire and Teacher Questionnaire. Opportunity-to-Learn Forms were submitted by 99 per cent of teachers. Based on September enrolments, the response rates for student materials were 91 per cent for the Student Questionnaire, 89 per cent for the Mental-Computation Questions and the Calculator Questions, and 85 per cent for the Student Assessment Booklets. It is not possible to determine a response rate for the Observation Booklets. Teachers sampled 12 students per class, but as some classes had fewer than 12 students the actual number expected is not known, though it is below 2000, which would result in a response rate of greater than 80 per cent.

3.5 Board Review Participants

Fifty-seven school boards carried out their own local reviews, using the questionnaires and test booklets created for the provincial review. The board reviews involved all schools offering mathematics under the jurisdiction of the participating boards. School boards had the option of including exceptional students and students in ESL programs. The board results do not form part of the information provided in this report.

Every school participating in a board review or in the provincial sample was provided with its own results. Board results were provided to those boards that conducted board reviews.

4. Principal Questionnaire

A profile of the school environments in which Grade 8 mathematics is taught in Ontario can be derived from the information collected by the Principal Questionnaire. The location of the school, and the leadership, the quality of staff, and the use and deployment of resources within it, combine to define the educational framework within which the school operates. The complete Principal Questionnaire and the responses to each question are presented in Appendix A.

4.1 Enrolment

The average enrolment in the schools which formed the sample for the review was 357. Ten per cent of the schools had an enrolment of fewer than 150 students; 11 per cent had 550 or more students. The average enrolment in Grade 8 mathematics was 53 students.

4.2 The Location of School and Structure of Program

Sixty-four per cent of the schools served urban or suburban areas, 34 per cent served rural areas, and 2 per cent served an isolated area.

The average number of hours of mathematics instruction reported was 142 per year. Forty-eight per cent of principals reported an allocation of 115 to 124 hours to mathematics instruction, and 46 per cent reported 125 or more hours.

4.3 Frequency of Staff Meetings on Mathematics

The highest percentage of principals (52 per cent) reported that teachers met fewer than five times per year to discuss mathematics programs. Eighteen per cent reported that meetings were held once every month or second month, and 15 per cent reported that teachers never met to discuss mathematics.

4.4 Use of Planning Documents

Principals reported that greater emphasis was placed on board- and school-level documents than on the Ministry of Education guideline. Board documents had the greatest emphasis, with 65 per cent of principals reporting that these were used "a lot".

4.5 Reviews of Mathematics Programs

Seventy per cent of principals reported that their school boards had a procedure for regularly reviewing mathematics programs. A lower percentage (43 per cent) reported that their schools had a regular procedure. Thirty-one per cent said that a review had occurred in the previous school year, and 33 per cent said there had been a review in the previous two to four years. These findings suggest that reviews are held on a frequent basis in the majority of schools.

The primary emphasis in the reviews was on resources, evaluation practices, and planning documents. Teaching practices were also included in the majority of reviews. Student-achievement measures were employed in 47 per cent of the mathematics reviews.

Approximately 80 per cent of principals reported that mathematics reviews lead to changes in teaching strategies, teaching objectives, and sequence and timing. Changes in school resources and student-evaluation practices were reported by a large number of principals (74 and 66 per cent, respectively).

4.6 Professional Development

According to principals, seminars/workshops and professional reading were the most popular means by which teachers engaged in professional development. Approximately half of principals also reported that teachers attended conferences and visited other classrooms. Peer coaching/job shadowing and credit courses, which were reported by only 35 and 17 per cent of principals, respectively, were a low priority among teachers as sources for professional development.

5. Teacher Questionnaire

The Teacher Questionnaire and the responses to each question are presented in Appendix B. Teachers were asked background questions and questions about teaching methods, resources, and evaluation strategies.

5.1 Characteristics and Educational Background

A majority of teachers of Grade 8 mathematics were male (60 per cent). Most had eleven or more years of teaching experience (77 per cent), 10 per cent had six to ten years, 8 per cent had two to five years, and 5 per cent had one year. Most of this experience was gained in elementary school; 84 per cent of teachers had not taught in secondary school.

Twelve per cent of teachers had taken no courses in mathematics methods as part of their education. Fifty per cent had taken one full course in mathematics methods, and 31 per cent had some instruction in mathematics methods as part of a general course. Only 7 per cent had taken two or more full courses in mathematics methods.

Sixty per cent of teachers reported that they did not take any full-year university courses in mathematics. Twenty per cent reported taking one full-year university course in mathematics; the remainder had taken more than two.

Thirty-eight per cent of teachers reported taking one course in measurement and evaluation or testing as part of their teacher training and/or graduate program, and 22 per cent had taken more than one such course. A high number (41 per cent) reported having taken no such course. Most teachers (78 per cent) had not had training in the use of computers to teach mathematics.

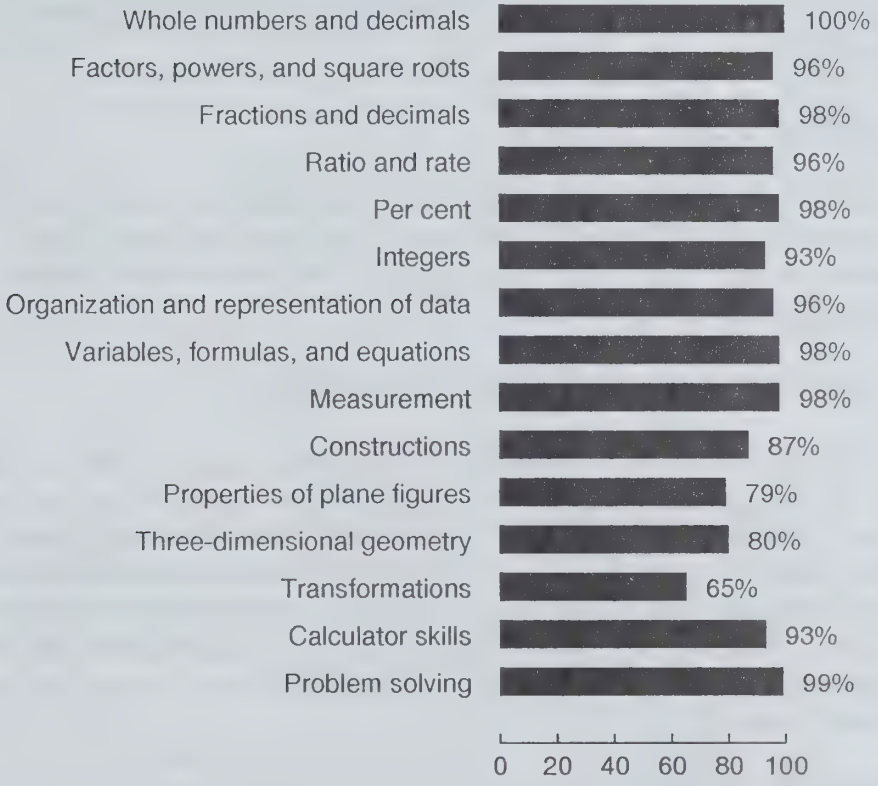
5.2 Importance of Mathematics Topics

Teachers were asked to rate the importance of instruction of selected topics in mathematics. The percentage of teachers rating each topic as "important" or "very important" is presented in Figure 1. More than 90 per cent of teachers rated most topics as "important" or "very important". The topics in geometry were the only ones that more than 10 per cent of teachers rated as "not important". The topics given greatest emphasis were problem solving, whole numbers and decimals, and per cent, which were rated as "very important" by 94, 86, and 78

per cent of teachers, respectively. The following topics were rated as "very important" by approximately 50 per cent of teachers: fractions and decimals; ratio and rate; variables, formulas, and equations; and measurement.

Figure 1
Relative Importance of Selected Mathematics Topics

Percentage of teachers rating each topic as "important" or "very important"



Percentages reported in the graph are based on raw data collected from the Teacher Questionnaire and may vary from the data summary reported in question 8 in Appendix B because of rounding.

5.3 Problem Solving

The average percentage of time devoted to the problem-solving process by teachers was 35 per cent. Teachers overwhelmingly (92 per cent) regarded problem solving as a component to be integrated into the mathematics program throughout the year, rather than as something to be taught as a separate unit. In teaching problem solving, they tried to provide students with a systematic approach (97 per cent) and to teach specific strategies (95 per cent). Eighty-two per cent of teachers also encouraged students to develop their own strategies. Eighty-seven per cent of teachers had students discuss their solutions with each other, 84 per cent had students report solutions to the whole class, and 81 per cent had students write up their solutions or results and present them to the teacher.

5.4 Homework

Forty-nine per cent of teachers reported that their students would take one to two hours per week to complete mathematics homework. Twenty-nine per cent of teachers reported that the students would take less than one hour.

5.5 Use of Calculators and Computers

Most teachers reported that students had access to computers (67 per cent). In the classrooms where computers were used, 36 per cent of teachers reported that less than 4 per cent of class time was given to having students use computers. When computers were available, teachers most frequently encouraged students to use them to practise new concepts and as an aid in doing projects. A significant number of teachers (43 per cent) also encouraged students to use computers to learn new concepts.

One-third of the teachers reported that calculators were used often in mathematics classes, that is, during every or almost every class, and 40 per cent reported that calculators were used during about half the lessons. Teachers encouraged students to use calculators to check answers to exercises (89 per cent), as an aid in doing projects (75 per cent), and to practise new concepts (60 per cent). The category of projects is interesting; only 44 per cent of students reported doing projects in mathematics, and most of these students reported doing projects only once in a while.

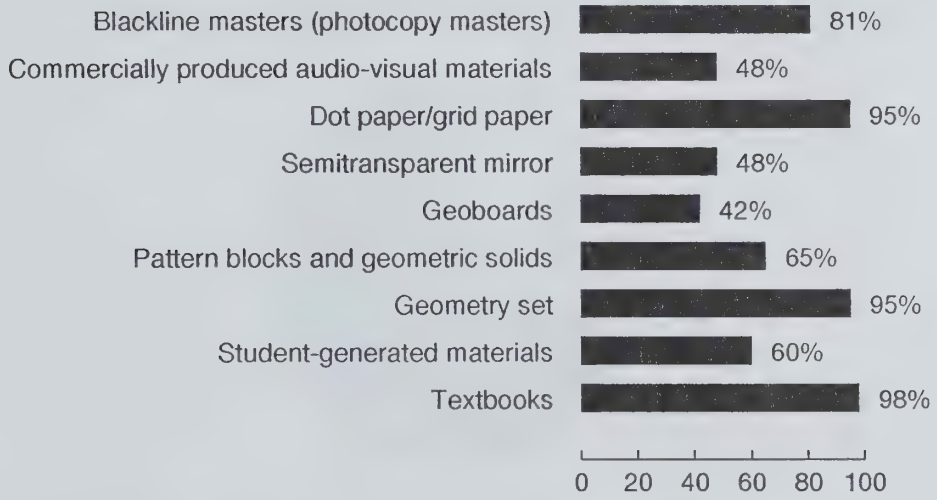
5.6 Instructional Materials

The resource used most frequently by teachers in preparing lessons was the textbook (77 per cent reported "a lot"). Board materials, the Ministry of Education guideline, and materials prepared by teachers also received moderately high emphasis (approximately 90 per cent of teachers reported using these "some" or "a lot"). Suggestions from students and commercially produced supplementary materials were used "some" by 60 per cent and 73 per cent of teachers, respectively.

Textbooks, dot paper/grid paper, geometry sets, and blackline masters were the most readily accessible materials for teachers. Teachers emphasized textbooks most heavily in their instruction, followed by geometry sets and dot paper/grid paper, and blackline masters. Textbooks were emphasized "a lot" by 83 per cent of teachers; the next-highest rating was for geometry sets, with 28 per cent of teachers responding "a lot". The percentage of teachers who reported placing "some" or "a lot" of emphasis on each resource is presented in Figure 2.

Figure 2
Emphasis Placed on Resources for Teaching Mathematics

Percentage of teachers who placed "some" or "a lot" of emphasis on each resource



Percentages reported in the graph are based on raw data collected from the Teacher Questionnaire and may vary from the data summary reported in question 18 in Appendix B because of rounding.

5.7 Teaching Methods

On average, teachers reported that they used a chalkboard and/or projector 43 per cent of the time. On average, teachers had students working individually for 29 per cent of the time. Teacher demonstrations with concrete materials, and cooperative group work were used to a lesser extent.

Thirty-four per cent of teachers reported that students worked in groups 10 to 19 per cent of the time, 28 per cent reported that students worked in groups 20 to 29 per cent of the time, and 24 per cent reported that this activity was used for 30 per cent or more of class time.

5.8 Evaluation

Teachers were asked what percentage of students' marks was determined through the use of various evaluation tools, including quizzes or short tests, cumulative or end-of-unit tests, formal examinations, observation of student behaviour, peer/self-evaluation, and projects and assignments. Cumulative or end-of-unit tests seemed to bear the most weight, along with quizzes or short tests. Together, they constituted 70 per cent of the final mark. Observation of student behaviour does play a part in evaluation, as does peer/self-evaluation, although these tools carry less weight. On average, observation determined 14 per cent of a student's mark, and projects and assignments 13 per cent.

6. Student Questionnaire

The Student Questionnaire and the student responses to each question are presented in Appendix C. Students were asked a series of questions to determine their attitudes towards or enjoyment of various types of mathematics questions, followed by questions on classroom procedures; on the significance of mathematics to their lives, both in and out of school; and on ways in which they deal with mathematics problems that they do not initially understand.

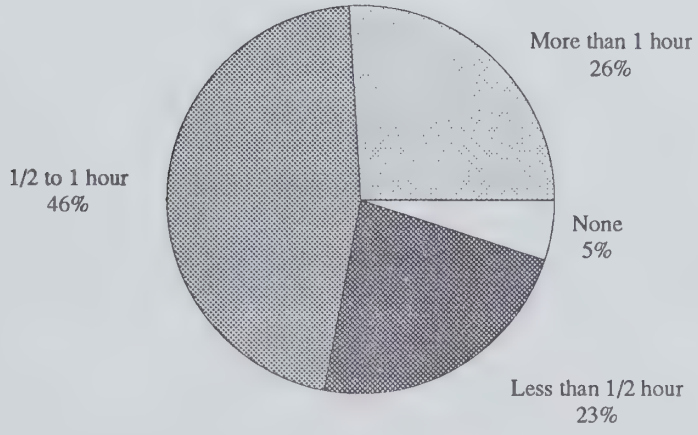
6.1 Background Characteristics

The sample surveyed was 50 per cent male and 50 per cent female. Eighty-four per cent of students sampled were born in 1976, 13 per cent in 1975, and 2 per cent in 1977. A high percentage (89 per cent) of students declared English to be the language of the home.

6.2 Mathematics Activities Outside School

As shown in Figure 3, most Grade 8 students reported doing some mathematics homework each week; 46 per cent reported doing a half to one hour, and 26 per cent reported doing more than one hour.

Figure 3
Amount of Mathematics Homework Done Each Week



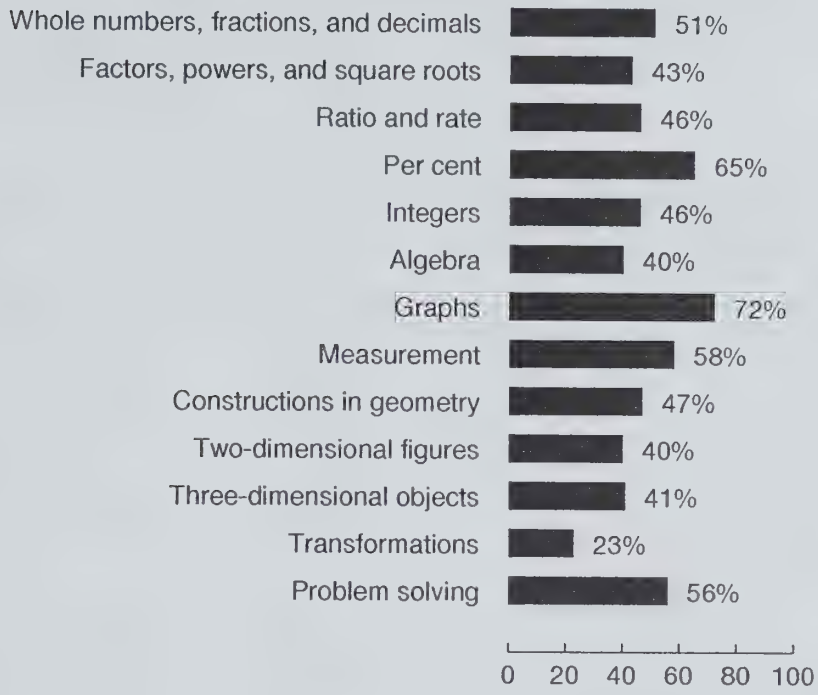
Students reported spending far more time watching television. Thirty-four per cent reported watching for one to two hours per day, and 48 per cent reported watching for more than two hours per day.

When mathematics is done at home, 46 per cent of students reported receiving occasional help from a family member. Forty-seven per cent of students reported that never, or almost never, did they receive help from a family member. This finding relates to a question, posed later in the questionnaire, in which students were asked whether they would wait and ask someone at home if they did not understand a mathematics problem. Fifty-two per cent said they would never wait, and 41 per cent said they would sometimes wait. This finding suggests that about half of the students do not regard or use family members as a main resource for mathematics problem solving or reinforcement.

6.3 Student Attitudes Towards Topics in Mathematics

Students were asked whether they liked doing questions dealing with thirteen specific mathematics topics. The percentage of students who said they liked doing questions in a specific topic is given in Figure 4. The majority of students liked doing questions that deal with graphs; per cent; measurement; problem solving; and whole numbers, fractions, and decimals. The topic with the highest response of "I'm not sure" was transformations (29 per cent), which might indicate that students do not understand this term. In addition, in relation to this topic 26 per cent responded "We do not do these kinds of questions".

Figure 4
Percentage of Students Who Like Each of Thirteen Topics in Mathematics



6.4 What Happens in Mathematics Classes

Students were asked about teaching procedures and student activities in the classroom. Student responses indicate that class time seems to be devoted primarily to presentations to the whole class as a group and work performed by the individual student. More than 80 per cent of students said that they did these activities almost every day. Thirty-one per cent of students said that they used a calculator almost every day, and 86 per cent said that they never used a computer. Details of responses to questions about classroom activities are provided in Table 2.

Table 2
Percentage of Students Reporting Frequencies of Classroom Activities in Mathematics

	Percentage of Students			
	Almost every day	*Once a week or so*	*Only once in a while*	*Never*
How often do you do mathematics at the board or on the overhead projector?	31	14	38	17
How often is mathematics presented to the whole class as a group?	84	5	7	4
How often do you do mathematics in small groups?	16	9	43	31
How often do you do mathematics on your own in class?	81	6	9	3
How often do you do projects on mathematics topics?	2	4	38	56
How often do you do projects in other subjects that involve the use of mathematics?	6	14	63	16
How often do you write tests or quizzes in mathematics?	4	43	52	1
How often do you use a calculator to do mathematics in class?	31	20	37	11
How often do you use a computer to do mathematics in class?	1	3	11	86
	Almost always	*Frequently*	*Occasionally*	*Never*
How often do you use a calculator for mathematics tests?	9	14	44	33

It may be that teachers generally adopt one of two approaches: they have students do mathematics at the board or on the overhead projector frequently, or they do not, as 31 per cent of students responded that they worked in this manner almost every day, whereas 38 per cent responded that they worked this way only once in a while.

Working in small groups did not seem to be a preferred way of doing mathematics. Thirty-one per cent of students responded that they never worked in this way; 43 per cent responded that they worked in this way only once in a while. Fifty-six per cent of students said that they never did projects in mathematics class. Students reported doing projects that

involved mathematics more frequently in other subjects; 63 per cent said they did this once in a while.

A majority of students (52 per cent) reported writing tests or quizzes once in a while, whereas 43 per cent reported doing them once a week or so.

6.5 Use of Calculators and Computers

Thirty-one per cent of students reported using a calculator almost every day in mathematics class, 20 per cent reported using a calculator once a week or so, and 37 per cent only once in a while. Thirty-three per cent of students said that they never used a calculator for mathematics tests, and only 9 per cent almost always used one.

Most students (86 per cent) reported that they never used a computer to do mathematics in class. Fifty-one per cent of students reported that they had a computer at home, but only 9 per cent reported using the computer for mathematics school work.

6.6 How Students Feel About Mathematics

Students' perceptions of the significance of mathematics both inside and outside the classroom and students' attitudes towards mathematics were the focus of a series of questions. Most students agreed that mathematics was for everyone equally (96 per cent), although a small group (2 per cent) thought it was more for males than females and another small group (1 per cent) believed the reverse. Most students (84 per cent) thought that mathematics helped them outside of school. Many students (54 per cent) felt that learning mathematics involves mostly memorizing, and most (94 per cent) felt that knowledge of mathematics was important in order to get a good job.

Sixty-seven per cent of students agreed or strongly agreed that they liked mathematics, whereas 18 per cent were not sure. These results are quite similar to those for the statement "I am good at mathematics". A small proportion (20 per cent) felt mathematics was difficult. Details of responses to these attitude statements are presented in Table 3.

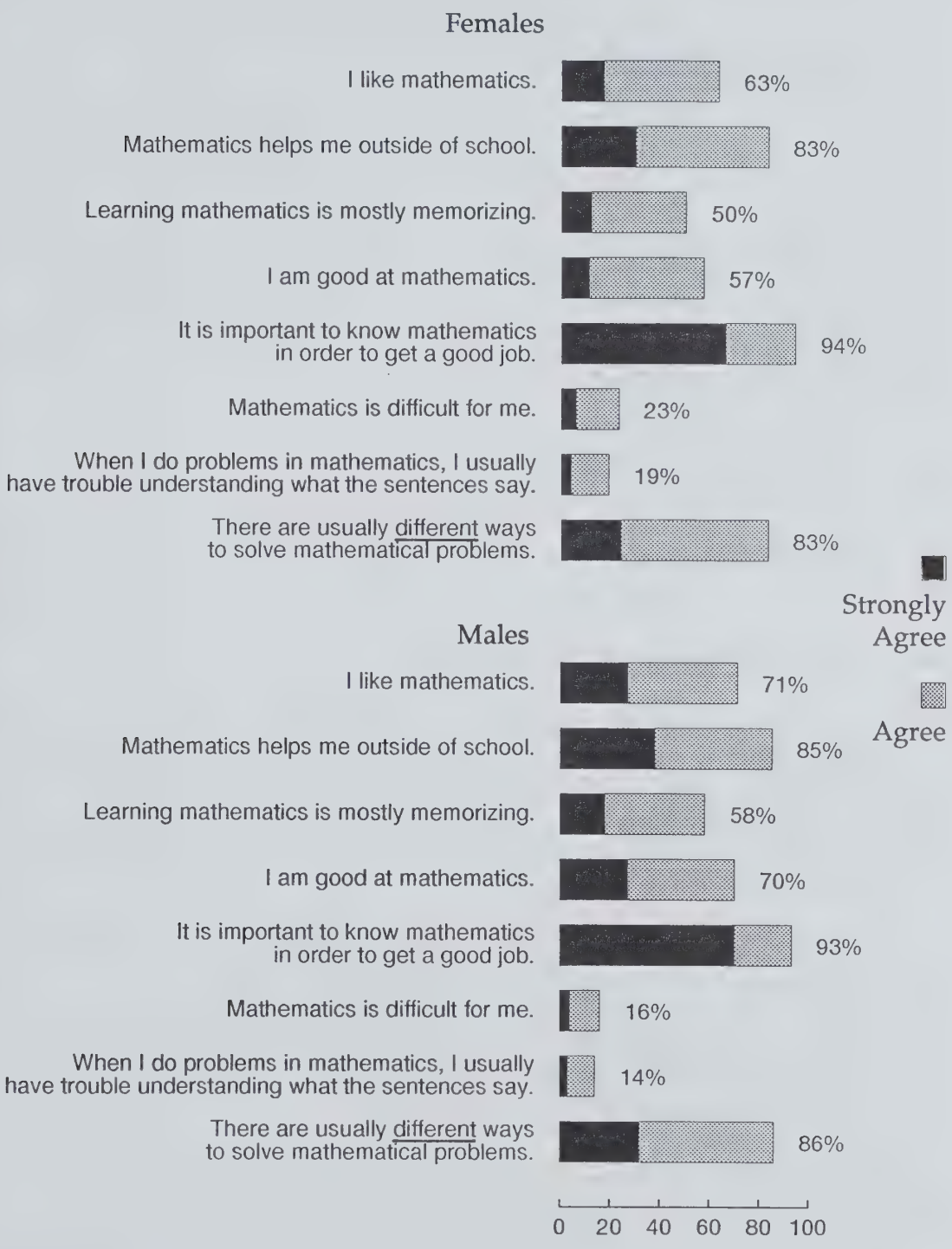
Table 3
Student Responses to Specific Attitudes Towards Mathematics

	Percentage of Students				
	SA	*A*	*NS*	*D*	*SD**
I like mathematics.	22	45	18	9	5
Mathematics helps me outside school.	34	50	11	4	1
Learning mathematics is mostly memorizing.	15	39	23	19	4
I am good at mathematics.	19	44	23	10	4
It is important to know mathematics in order to get a good job.	68	26	4	2	1
Mathematics is difficult for me.	5	15	20	39	21
When I do problems in mathematics, I usually have trouble understanding what the sentences say.	4	13	19	45	20
There are usually different ways to solve mathematical problems.	28	57	12	2	1

**SA* = Strongly Agree; *A* = Agree; *NS* = Not Sure; *D* = Disagree; *SD* = Strongly Disagree

Student attitudes towards mathematics differed in some respects, according to gender. Results by gender are shown in Figure 5. A larger percentage of male students than female students said they liked mathematics, and male students appear to be more confident about mathematics: a higher percentage of male students than female students (70 as compared to 57 per cent) reported that they were good at mathematics, and fewer male students than female students (16 as compared to 23 per cent) indicated that they found mathematics difficult.

Figure 5
Gender Differences in Student Attitudes Towards Mathematics


Females
I like mathematics.
63%
Mathematics helps me outside of school.
83%
Learning mathematics is mostly memorizing.
50%
I am good at mathematics.
57%
It is important to know mathematics in order to get a good job.
94%
Mathematics is difficult for me.
23%
When I do problems in mathematics, I usually have trouble understanding what the sentences say.
19%
There are usually different ways to solve mathematical problems.
83%
Strongly Agree
Agree
Males
I like mathematics.
71%
Mathematics helps me outside of school.
85%
Learning mathematics is mostly memorizing.
58%
I am good at mathematics.
70%
It is important to know mathematics in order to get a good job.
93%
Mathematics is difficult for me.
16%
When I do problems in mathematics, I usually have trouble understanding what the sentences say.
14%
There are usually different ways to solve mathematical problems.
86%
0 20 40 60 80 100

The percentage of students selecting "strongly agree" and "agree" in response to these opinion statements, by gender, is given in Table 4.

Table 4
Student Responses to Attitude Statements by Gender

	Percentage of Students			
	Female		*Male*	
	SA	*A*	*SA*	*A**
I like mathematics.	17	46	27	44
Mathematics helps me outside of school.	30	53	38	47
Learning mathematics is mostly memorizing.	12	38	18	40
I am good at mathematics.	11	46	27	43
It is important to know mathematics in order to get a good job.	66	28	70	23
Mathematics is difficult for me.	6	17	4	12
When I do problems in mathematics, I usually have trouble understanding what the sentences say.	4	15	3	11
There are usually different ways to solve mathematical problems.	24	59	32	54

**SA* = Strongly Agree; *A* = Agree

6.7 Solving Mathematics Problems

There were two statements on problem solving among the attitude statements reported in Tables 3 and 4 and Figure 5. Only 17 per cent of students said that they had trouble understanding the sentences used to present problems; 19 per cent said that they were not sure. Most students (85 per cent) recognized that there were usually different ways to solve mathematical problems.

Table 5 tabulates the percentage of responses of students to the series of questions on how they dealt with problems that they did not understand. Most students (over 90 per cent) responded that they sometimes or often sought help from other students or the teacher when they did not understand a problem in mathematics. Ninety-six per cent said that they tried to solve it on their own.

A small percentage of students (41 per cent) reported that they sometimes or often gave up on problems; 58 per cent said that they never did. Few students sought help at home.

Table 5
Specific Methods of Dealing With Difficult Mathematics Problems

When you don't understand a problem in mathematics, do you:	*Percentage of Students*		
	Often	*Sometimes*	*Never*
Try different ways to solve it on your own?	40	56	4
Ask another student for help?	25	68	7
Ask your teacher for help?	21	68	10
Wait and ask someone at home?	6	41	52
Just give up?	4	37	58

7. Planning Documents

As part of the assessment of the intended curriculum in the Grade 8 mathematics program, planning documents were collected from all schools and boards involved in the provincial sample. These documents were then analysed by a document analysis team of three teachers and one consultant. The purpose of this analysis was to describe what planning documents teachers of Grade 8 mathematics refer to in preparing their daily lesson plan.

The documents that were analysed varied widely in both depth and detail. Some were developed for system-wide use in all schools within a board; others were developed by teachers at the school for use in their own classes. Generally it was found that, if the document had been developed at the board or system level, it was more likely to contain a statement of philosophy, a rationale, and a set of goals; if it had been developed by a teacher for only that teacher's use, it was more likely to be a functional document consisting of a list of required teaching topics, with an emphasis on knowledge and skills.

In some instances, partial documents were sent in for analysis. For example, a curriculum document on intermediate mathematics that included courses from Grades 7 to 10 would have been disassembled and the Grade 8 chapter submitted separately for analysis. In such a case, the document analysis team was unable to determine whether sections of the document not included, or its introduction, might have contained general information on the teaching of mathematics, evaluation of the program, goals of the intermediate mathematics program, and so on. Furthermore, special documents on evaluation produced by some boards were not submitted because they were not part of the Grade 8 mathematics planning document. Because of these anomalies, the data gathered from the planning documents should be interpreted broadly. Appendix F contains a detailed summary of the data compiled by the document analysis team.

7.1 Type of Document

Documents were of two types: board level (produced by school boards and designed to be used in all Grade 8 mathematics classes) and school level (produced in a school for use only in that school). Of the Grade 8 documents analysed, twenty-nine were board level and fifty were school level.

7.2 Rationale/Objectives

Only 14 per cent of the school-level documents contained a statement of philosophy or rationale. Sixty-two per cent of the board-level documents included such a statement. Specific objectives of the mathematics program were included more frequently: in 38 per cent of school-level documents and 96 per cent of board-level documents.

The analysis team looked for three types of objectives: attitudes, skills, and knowledge. Skill and knowledge objectives were referred to in most of the documents where objectives were mentioned; attitudinal objectives in fewer cases. Of school-level documents, 4 per cent mentioned attitudinal objectives; of board-level documents, 29 per cent.

7.3 Content Areas

All the documents included in this analysis were based upon the curriculum guideline *Mathematics: Intermediate and Senior Divisions, 1985. Part Two or Part Three: Grades 7 and 8.* The guideline lists both compulsory and optional topics. For the most part, board and school documents included all the compulsory topics. Approximately half of the documents listed the optional topics. More board-level than school-level documents listed the optional topics.

Table 6 lists the compulsory and optional topics from the guideline. It shows, for each category, the percentage of documents that included the topic listed.

Table 6
Percentage of School- and Board-Level Documents Dealing with Guideline Topics

Guideline topics	*School-level documents*	*Board-level documents*
Numerical Methods and Algebra		
Calculator skills	60	74
Whole numbers and decimals	100	100
Factors, powers, and square roots	92	100
Fractions and decimals	100	100
Ratio and rate	100	96
Per cent	98	100
Integers	94	100
Organization and representation of data	88	100
Variables, formulas, and equations	96	96
Relations (optional)	40	59
Mathematics and the computer (optional)	22	58
Probability (optional)	27	56
Measurement and Geometry		
Measurement	98	100
Constructions	94	96
Properties of plane figures	90	93
Three-dimensional geometry	85	100
Transformations	96	96
Core extensions or options	3	38

7.4 Teaching Methods

The majority of board-level documents included some suggestions on teaching methods: they provided specific teaching techniques, learning strategies, lesson plans, sample tasks for students, and various teaching approaches for Grade 8 mathematics. Instructional methods or teaching strategies were included in 57 per cent of board-level documents and 18 per cent of school-level documents.

7.5 Calculators and Computers

The use of calculators in the Grade 8 mathematics classes was discussed in 68 per cent of board-level documents and 27 per cent of school-level documents. While students have access to computers in most schools in Ontario, student use of them is quite low, according to the Student Questionnaire. The inclusion of computers in the planning documents is correspondingly low: 39 per cent in board-level documents and 18 per cent in school-level documents.

7.6 Evaluation Practices

Many boards in Ontario have produced documents dealing specifically with evaluation. Even so, many of the planning documents included additional information for teachers about evaluation related to the Grade 8 mathematics program. Where evaluation did form part of the document, reference was made to formative and summative evaluation techniques.

References to evaluation in both the board- and school-level documents included a variety of formative evaluation techniques and strategies: the student's previous achievement, pretests for diagnostic purposes, written tests, systematic observation, oral presentations, informal questioning, teacher-student interviews or discussions, self-evaluation, and peer evaluation. Summative evaluation techniques included unit tests, post-tests, examinations, standardized tests, as well as projects and essays.

7.7 Conclusion

An analysis of the planning documents for Grade 8 mathematics at the school and board levels reveals that boards have historically invested an enormous amount of energy and resources into curriculum development. It also demonstrates that teachers of Grade 8 mathematics are willing to try a wide variety of teaching and evaluation techniques to make the teaching of mathematics more relevant for Grade 8 students.

8. Student Achievement

A number of instruments were used to determine whether or not students were achieving the goals of the Grade 8 mathematics program. These instruments included multiple-choice questions, questions requiring short answers, and problems requiring extended responses. Students were not allowed to use calculators for the main portion of the assessment; however, twelve questions were designed to test students' ability to use calculators. The following areas of the curriculum were covered by the instruments: numerical methods and algebra, measurement and geometry, process problems, calculator skills, and mental computation. Teachers also observed students working individually with materials. The questions measured students' ability to recall, understand, and apply mathematical facts, skills, and concepts, and to select and carry out a strategy to solve an unfamiliar problem. More detailed descriptions of the assessment instruments and curriculum areas are presented in "3. Description of the Measures and Samples for the Provincial Review".

The results were reviewed by an interpretation panel, which rated student performance on the following five-point scale:

5 – superior
4 – strong
3 – satisfactory
2 – marginal
1 – weak

Student achievement in Grade 8 mathematics was rated as *satisfactory* or better for more than half of the curriculum areas that were assessed. Achievement was rated as *strong* in the organization and representation of data, in three-dimensional geometry, and in calculator skills; and *satisfactory* to *strong* in whole numbers and decimals. Student performance was rated as *satisfactory* in the following areas:

- factors, powers, and square roots
- ratio and rate
- variables, formulas, and equations
- properties of plane figures
- hands-on tasks (observation activities)

The following topics were identified as areas of concern when improved performance would be desirable:

- per cent
- integers
- measurement
- constructions
- transformations
- mental computations

Student performance was rated as *weak* in fractions and process problems.

Questions for each of the areas of the curriculum are presented in Appendix D, along with the percentage of students answering each question correctly and the ratings of the interpretation panel (Tables D-1 to D-17). The results for each curriculum area are summarized in Table D-18 in Appendix D.

The five Student Assessment Booklets were randomly distributed within each class so that one-fifth of the students in the provincial sample answered each booklet. Since each student did not answer all questions, there is a degree of uncertainty associated with the provincial statistics (sampling error). The magnitude of this uncertainty for each curriculum area and for individual questions is specified in Appendix E in the form of confidence-band widths. For example, the confidence-band width associated with the mean percentage correct for numerical methods and algebra was ± 0.5 per cent, and the reported mean percentage correct was 66.5. The confidence band for numerical methods and algebra was, therefore, 66.0 to 67.0 per cent. The mean percentage correct would fall within this range 95 per cent of the time if the review were repeated with a similar sample.

In the presentation of results, achievement is reported as the average percentage correct for the questions on each topic. Ratings provided by the interpretation panel are also presented. Since the questions on one topic might be considerably more difficult than the questions on another topic, it is not advisable to compare the results on the different topics solely on the basis of average percentage correct. When the interpretation panel members reviewed the results, they considered the difficulty of the question, the expected performance level for Grade 8 mathematics students for the question, and the students' actual achievement. On that basis, the panel rated strength and weakness.

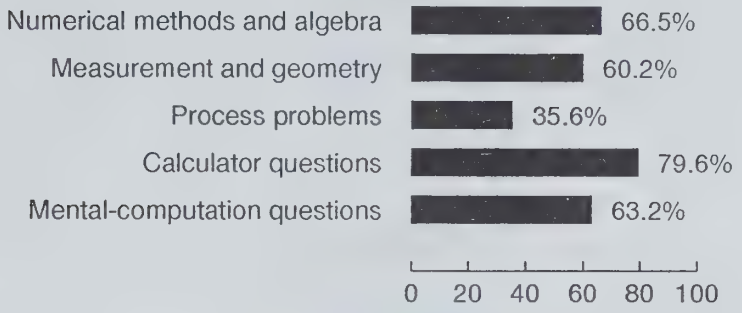
Table 7 indicates the percentage of questions within each area of the curriculum for which student performance was given a particular rating by the interpretation panel. For example, performance on 50 per cent (six of twelve) of calculator questions was rated as *strong*. The panel rated performance as *satisfactory* on 34 per cent of the measurement and geometry questions, and as *marginal* on 30 per cent of the questions on numerical methods and algebra. Performance on four of eight (50 per cent) process problems was rated *as weak*.

Table 7
Percentage of Questions Within Each Curriculum Area Receiving Each Panel Rating

	Percentage of Questions				
Rating	*Numerical methods and algebra*	*Measurement and geometry*	*Process problems*	*Calculator questions*	*Mental-computation questions*
Superior	5	3	0	17	5
Strong	15	13	0	50	0
Satisfactory	34	34	12	17	30
Marginal	30	32	38	17	35
Weak	17	18	50	0	30

A summary of the average percentage correct for each curriculum area is presented in Figure 6.

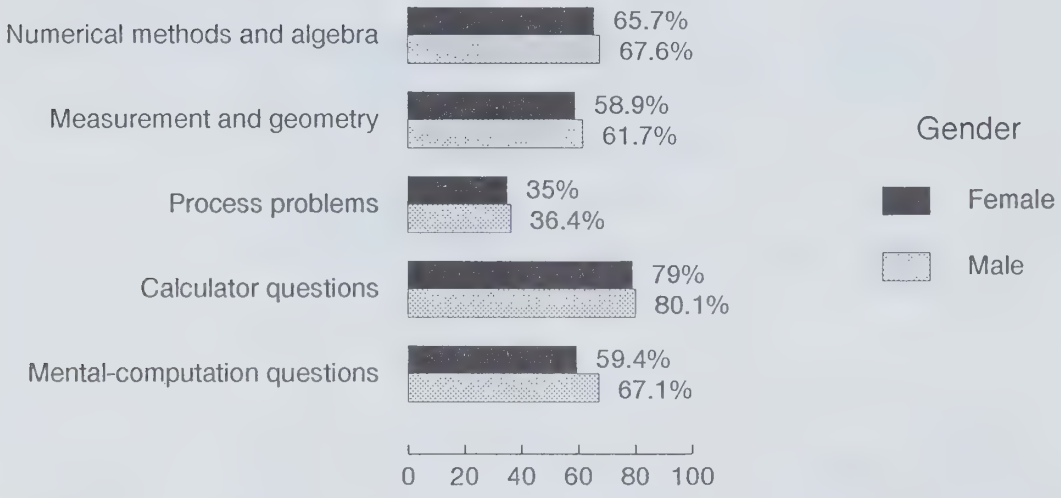
Figure 6
Summary of Mathematics Achievement (Percentage Correct) by Curriculum Area



The panel ratings were: *satisfactory* for numerical methods and algebra, *satisfactory* for measurement and geometry, *weak* for process problems, *strong* for calculator questions, and *marginal* for mental-computation questions.

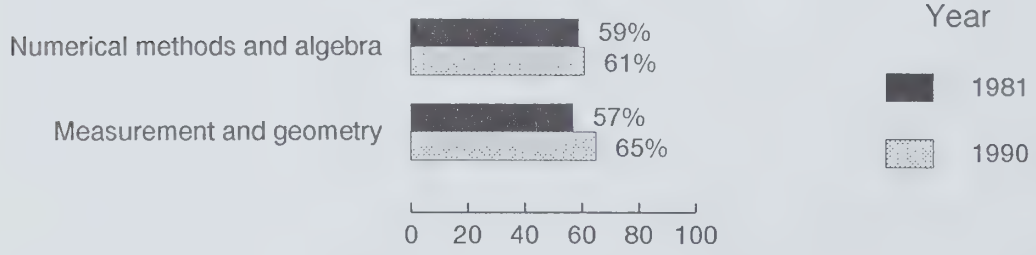
The average percentage correct for male and female students is given in Figure 7. Achievement levels are slightly higher for male students than for female students for all topics.

Figure 7
Average Student Achievement for Each Curriculum Area by Gender



Forty questions that were answered by Grade 8 students in Ontario in 1981 as part of the Second International Mathematics Study were included in the current provincial review. As shown in Figure 8, students scored considerably higher in 1990 than in 1981 on questions in measurement and geometry. Achievement was slightly higher in 1990 for numerical methods and algebra.

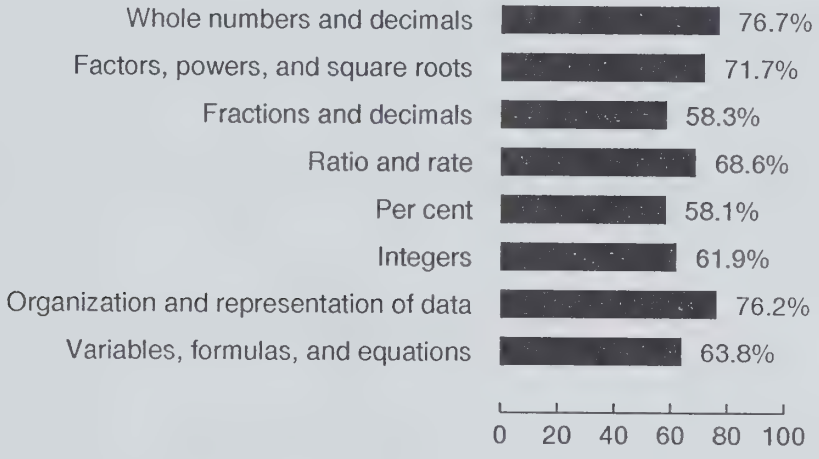
Figure 8
Achievement Scores in 1981 and 1990



8.1 Numerical Methods and Algebra

By the end of Grade 8, students are expected to do calculations with whole numbers, decimals, and fractions, and to apply these to solve word problems. Students are expected to demonstrate an understanding of integers, factors, powers, square roots, per cent, ratio, and rate, and to apply these to practical problems. Students are also expected to produce and interpret several types of graphs and to use algebraic variables, formulas, and equations. The results for achievement in numerical methods and algebra are shown in Figures 9 and 10.

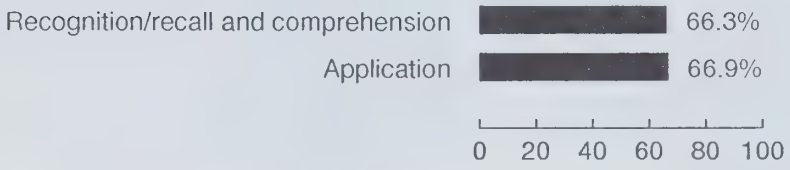
Figure 9
Student Achievement in Numerical Methods and Algebra by Topic



The interpretation panel ratings were: *strong* for organization and representation of data, and between *satisfactory* and *strong* for whole numbers and decimals. Student achievement was rated as *satisfactory* on the following topics: factors, powers, and square roots; ratio and rate; and variables, formulas, and equations. Performance on per cent and integers was rated as *marginal* and on fractions as *weak.*

Questions on numerical methods and algebra were classified as comprehension or application as described in "3.1 The Instruments". Averages for percentage correct for the questions in these cognitive levels are presented in Figure 10.

Figure 10
Student Achievement in Numerical Methods and Algebra by Cognitive Level



Whole Numbers and Decimals

There were fifteen questions on this topic, and the panel rated the results as *satisfactory*. The results were rated as *strong* for five questions, *satisfactory* for seven questions, and *marginal* for three questions. Question 83 (reproduced below) is one of the questions on which performance was rated as *strong*. The interpretation panel felt that it would be appropriate for students to use a calculator for some of the questions.

Question 83

Which symbol (+, −, ×, ÷) must replace the box to make a true statement?

$(4 + 6) \square\ 2 - 5 = 0$

Student Responses

2%	A)	+
*84%	B)	÷
6%	C)	×
6%	D)	−
2%	omit	

Ten questions required addition, subtraction, multiplication, or division of whole numbers and decimals; results were rated as *strong* on three of these questions, as *satisfactory* on five, and as *marginal* on two. Question 2 (reproduced below) is one of these questions with a *satisfactory* rating.

Question 2

Calculate 34 + 30.6 + 47.08.

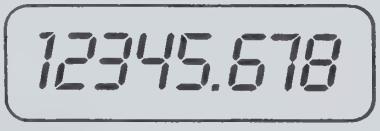
Student Responses

4%	A)	50.48
3%	B)	77.68
9%	C)	111.14
*84%	D)	111.68

Three questions measured students' understanding of place value. Question 81 (reproduced below) is one of these questions with a *marginal* rating.

Question 81

Here is a calculator display.



Which digit is in the thousandths place?

Student Responses

*69%	A)	8
6%	B)	6
23%	C)	2
1%	D)	1

Two questions required the conversion of a fraction to a decimal or to a per cent; the results for both questions received a rating of *weak*. The interpretation panel felt that some students may have read "thousands" rather than "thousandths".

Factors, Powers, and Square Roots

There were eleven questions on this topic, and the panel rated the results as *satisfactory*. The results were rated as *superior* for one question, *strong* for two questions, *satisfactory* for four questions, *marginal* for two questions, and *weak* for two questions. Question 126 (reproduced below) is the question on which the results were rated as *superior*.

Question 126

The expression $2 \times 2 \times 2 \times 3 \times 3$ is equal to:

Student Responses

2%	A)	$6 + 9$
2%	B)	$3 \times 2 \times 2 \times 3$
1%	C)	12
*95%	D)	$2^3 \times 3^2$

There were three other questions on powers; the results on two of these questions were rated as *marginal* and on one as *satisfactory*. Of the three questions on factors, the results for two received a *satisfactory* rating and the other *strong*. Two questions measured students' understanding of the terms "prime number" and "perfect square"; results for both questions were rated as *weak*. Question 125, which was one of these, is reproduced below.

Question 125

Which of the following is a prime number?

Student Responses		
19%	A)	99
*41%	B)	79
17%	C)	69
20%	D)	49
2%	omit	

On two other questions, 92 per cent of students recognized 9 as the square root of 81, and 79 per cent recognized 25 as the square of 5. These results were rated as *strong* and *satisfactory*, respectively.

Fractions

There were fifteen questions on this topic, and the panel rated the results as *weak*. The results on one question were rated as *strong*, and on three as *satisfactory*. The results on the remaining eleven questions were rated as less than *satisfactory*; on four as *marginal* and on seven as *weak*. The results for question 166 (reproduced below) were rated as *strong*.

Question 166

Which of the following is a pair of equivalent fractions?

Student Responses

*86%	A)	$\frac{3}{5}$ and	$\frac{9}{15}$
2%	B)	$\frac{5}{6}$ and	$\frac{2}{3}$
4%	C)	$\frac{4}{5}$ and	$\frac{14}{15}$
2%	D)	$\frac{5}{8}$ and	$\frac{2}{3}$
5%	E)	$\frac{1}{2}$ and	$\frac{14}{24}$
1%	omit		

Five questions involved addition and subtraction of fractions; the results on three were rated as *marginal* and on two as *satisfactory*. Three questions involved multiplication and division of fractions; the results on two were rated as *weak* and one as *marginal*. One of these – question 87 (reproduced below) – was a word problem. The result of 49 per cent correct was rated *weak*.

Question 87

Skates were on sale for $\frac{1}{3}$ off. The regular price was $60. How much was the sale price?

Student Responses

4%	A)	$10
38%	B)	$20
8%	C)	$30
*49%	D)	$40
1%	omit	

Three questions involved the conversion of fractions to decimals and decimals to fractions; the results for all three were rated as *weak*. Question 8 (reproduced below) is one of these questions. The interpretation panel felt that the two questions on conversion of mixed fractions to decimals had very little practical application and possibly should not have been included.

Question 8

The fraction $\frac{5}{8}$ written in decimal form is:

Student Responses

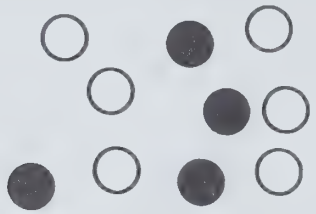
8%	A)	1.6
*48%	B)	0.625
39%	C)	0.58
4%	D)	0.375

The interpretation panel indicated that this is an abstract idea, and students should have concrete materials to use, both in learning this concept and in answering questions on this concept.

The results for question 167 (reproduced below) were rated as *satisfactory*. The question measures students' understanding of the physical representation of fractions.

Question 167

The picture shows some black and some white marbles.



What fraction of the marbles is white?

Student Responses

16%	A)	$\frac{4}{10}$
*73%	B)	$\frac{6}{10}$
4%	C)	$\frac{4}{6}$
6%	D)	$\frac{6}{4}$
0%	E)	$\frac{1}{2}$

Ratio and Rate

There were thirteen questions on this topic, and the panel rated the results as *satisfactory*. Student achievement was rated as *strong* on four questions, *satisfactory* on five questions, and *marginal* on four. The results on two questions dealing with equivalent ratios were rated as *strong*. Question 130 (reproduced below) was one of these questions.

Question 130

The ratio 16:12 in lowest terms is:

Student Responses

*84%	A)	4:3
1%	B)	6:8
11%	C)	8:6
4%	D)	3:4

Nine of the questions dealt with practical applications of ratio. The results on question 170 (reproduced below) were rated as *satisfactory.*

Question 170

A painter is to mix green and yellow paint in the ratio of 4 to 7 to obtain the colour he wants. If he has 28 L of green paint, how many litres of yellow paint should be added?

Student Responses

8%	A)	196 L
*62%	B)	49 L
9%	C)	28 L
15%	D)	16 L
5%	E)	11 L
1%	omit	

The results for question 91 (reproduced below) were rated as *marginal.*

Question 91

For the annual school play, the ratio of adult tickets sold to student tickets sold was 5:3. If 90 adult tickets were sold, what was the total number of tickets sold?

Student Responses

22%	A)	54
14%	B)	105
*42%	C)	144
20%	D)	150
2%	omit	

Per Cent

There were sixteen questions on this topic, and the panel rated the results as *marginal*. The results were rated as *strong* on one question, *satisfactory* on three questions, *marginal* on six questions, and *weak* on six questions. Five questions involved the application of per cent in practical problems about interest, discounts, sales tax, and commissions. The results on four of these were rated as *marginal* and on one as *satisfactory*. Question 14 (reproduced below) is the question for which the results were rated as *satisfactory*.

Question 14

What is the interest for 1 year on a loan of $800 at 13% per year?

Student Responses

*79%	A)	$104
3%	B)	$800
12%	C)	$904
5%	D)	$1 704
1%	omit	

Of the five questions involving the conversion of fractions and decimals to per cent and vice versa, the results on four were rated as *weak* and on one as *satisfactory*. Question 163 (reproduced below) is one of the questions with a *weak* rating.

Question 163

The fraction $\frac{1}{5}$ is equal to:

Student Responses

18%	A)	0.20%
6%	B)	2%
14%	C)	5%
*59%	D)	20%
3%	E)	25%
1%	omit	

Integers

There were fifteen questions on this topic, and the panel rated the results as *marginal*. The results on one question were rated as *superior* and on two as *strong*. The results were rated as *satisfactory* on two questions, *marginal* on six questions, and *weak* on four. Question 55 (reproduced below) received the rating of *superior*.

Question 55

Which of these integers is greater than –3?

Student Responses

*94%	A)	0
2%	B)	–4
1%	C)	–6
1%	D)	–10
1%	omit	

Question 55 is one of four questions that measured students' understanding of the representation of integers on a number line and the relative sizes of integers: the results on two of these questions were rated as *strong* and on one as *satisfactory*. This was the strongest area of achievement in this topic.

Addition and subtraction were assessed in five questions; the results were rated as *satisfactory* on one question, *marginal* on three, and *weak* on one. Question 18 (reproduced below) is one of the questions with a rating of *marginal*.

Question 18

Calculate (–8) – (–7).

Student Responses

11%	A)	+15
8%	B)	+1
*55%	C)	–1
27%	D)	–15

Four questions involved the representation of integer pairs on a grid; the results were rated as *marginal* on two questions and as *weak* on two. The interpretation panel felt that students might not be familiar with the term "grid". Panel members pointed out that this is a new concept in Grade 8, and that it is frequently taught near the end of the school year. Approximately half of the teachers said they had not taught this concept; one-third said they had planned to teach it later in the school year.

Two questions involved the application of integers to temperature. The results on question 193 (reproduced below) were rated as *weak*; the results on the other question were rated as *marginal*.

Question 193

The air temperature at the foot of a mountain is 31°C. On top of the mountain the temperature is −7°C. How much warmer is the air at the foot of the mountain?

Student Responses

7%	A)	−38°
7%	B)	−24°
4%	C)	7°
32%	D)	24°
*49%	E)	38°
1%	omit	

Organization and Representation of Data

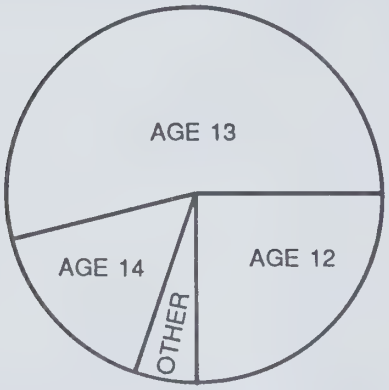
There were fourteen questions on this topic and the results were rated as *strong*. This topic was one of only two for which results were rated as *strong*. The results were rated as *superior* on four questions and as *strong* on two. The results on five questions were rated as *satisfactory* and on three questions as *marginal*.

The questions presented a variety of data in the form of pictographs, bar graphs, circle graphs, and line graphs. Question 100 (reproduced below) is an example of a question with a rating of *superior*.

Question 100

The circle graph below shows the ages of students in Grade 8.

GRADE 8 STUDENT AGES
OAK ROAD SCHOOL



According to the above graph, which statement is definitely true about Grade 8 students in Oak Road School?

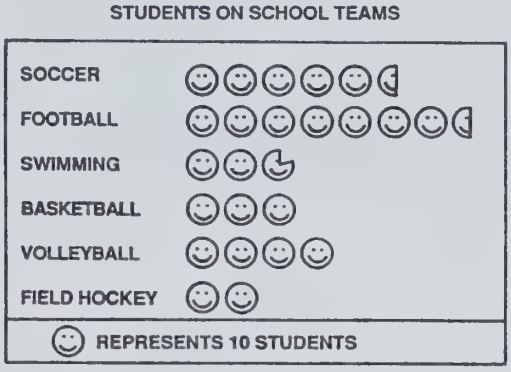
Student Responses

4%	A)	There are absolutely no 15-year-olds.
2%	B)	There are definitely some 10-year-olds.
*92%	C)	There are more 12-year-olds than 14-year-olds.
2%	D)	There are more 14-year-olds than 13-year-olds.

Question 19 (reproduced below) is an example of a question with a rating of *satisfactory*.

Question 19

The diagram below shows the number of students on some school teams.



What was the total number of students on the football and soccer teams?

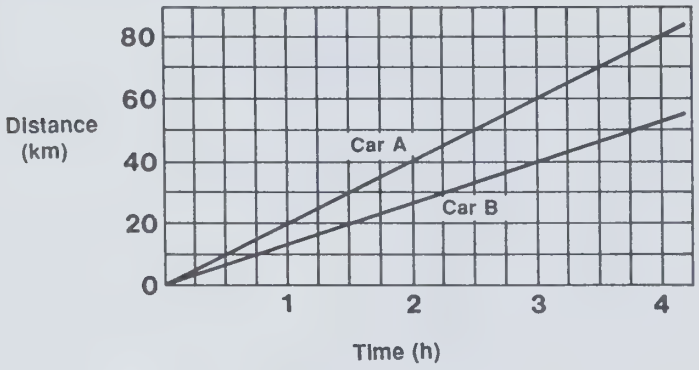
Student Responses

*84%	A)	130
2%	B)	120
13%	C)	13
1%	D)	12

Question 190 (reproduced below) is an example of a question with a rating of *marginal.*

Question 190

Look at the graph below.



Three hours after starting, Car A is how many kilometres ahead of Car B?

Student Responses

13%	A)	2
8%	B)	10
6%	C)	15
*58%	D)	20
14%	E)	25
1%	omit	

Variables, Formulas, and Equations

There were sixteen questions on this topic, and the panel rated the results as *satisfactory*. The results were rated as *satisfactory* on ten questions and as *marginal* on six. For seven questions, students were required to write an algebraic expression or equation to represent a set of conditions. The results were rated as *satisfactory* on four questions and as *marginal* on three. Question 62 (reproduced below) is one of those questions with a rating of *satisfactory*.

Question 62

Sixteen added to the product of three and a number is 31. An equation for this statement is:

Student Responses

4%	A)	$3m - 16 = 31$
4%	B)	$3m \times 16 = 31$
*68%	C)	$3m + 16 = 31$
22%	D)	$3(16) + m = 31$
1%	omit	

Five questions required students to find the value of an algebraic expression. The results were rated as *satisfactory* on four of these questions and as *marginal* on one. Question 142 (reproduced below) is one of those questions with a rating of *satisfactory*.

Question 142

What is the value of $a^2 + b^3$ if $a = 3$ and $b = 2$?

15%	A)	12
8%	B)	13
11%	C)	15
*65%	D)	17
1%	omit	

Three questions required students to solve an algebraic equation. The results were rated as *satisfactory* on two of these questions and as *marginal* on one. Question 144 (reproduced below) is the question with the rating of *marginal*.

Question 144

What is the value of p in $\frac{p}{2} + 5 = 9$?

Student Responses

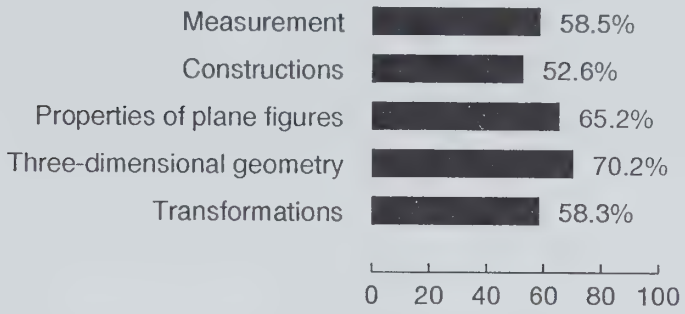
33%	A) 4
7%	B) 7
*55%	C) 8
3%	D) 14
2%	omit

8.2 Measurement and Geometry

By the end of Grade 8, students are expected to be able to calculate perimeters and areas of rectangles, triangles, parallelograms, and figures with irregular shapes. They are also expected to be able to calculate circumference and area of a circle, the surface area of rectangular and triangular prisms, and the volume of rectangular and non-rectangular prisms. The use of metric units is another aspect of measurement studied by Grade 8 students. In the area of geometry, students are expected to construct perpendicular and parallel lines, perpendicular bisectors, angle bisectors, and various angles and figures. Students are required to identify and use properties of plane figures such as supplementary-angle properties, the sum-of-the-angles property of triangles, and the Pythagorean theorem. Students are also required to classify, recognize, and sketch three-dimensional objects and to work with transformations (translation, reflection, and rotation).

The average percentage correct for each topic in measurement and geometry is given in Figure 11. The interpretation panel rated the results as *strong* for three-dimensional geometry, *satisfactory* for properties of plane figures, and *marginal* to *satisfactory* for transformations. Student performance in measurement and in constructions was rated as *marginal*.

Figure 11
Student Achievement in Measurement and Geometry by Topic



Questions were classified according to the following cognitive levels (described in "3.1 The Instruments"): recognition or recall, comprehension, and application. As only two questions tested recognition or recall, achievement on questions in geometry and measurement testing recognition or recall was combined with achievement on questions testing comprehension. Averages for percentage correct for the questions in the cognitive levels are presented in Figure 12.

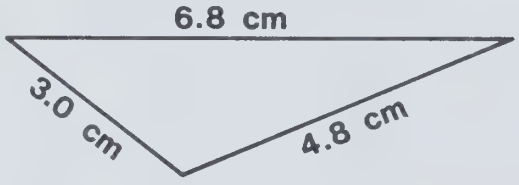
Figure 12
Student Achievement in Measurement and Geometry by Cognitive Level

Measurement

There were 24 questions on this topic and the panel rated the results as *marginal*. Student achievement was rated as *strong* on four questions, *satisfactory* on seven questions, *marginal* on eight questions, and *weak* on five. The interpretation panel felt that there were too many new topics in measurement introduced in Grade 8 mathematics. Panel members also expressed concern about the amount of vocabulary to be learned. Question 148 (reproduced below) is an example of a question with a rating of *strong*.

Question 148

The dimensions of a triangle are given below.



What is the perimeter of this triangle?

Student Responses

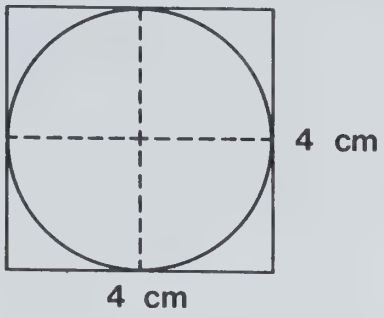
*94%	A) 14.6 cm
2%	B) 7.8 cm
2%	C) 7.3 cm
2%	D) 13 cm
1%	omit

Of the other three questions on perimeter, the results on two were rated as *satisfactory* and on one as *marginal*.

The results for most of the questions involving the calculation of area using a formula were rated as *marginal*. Question 64 (reproduced below) is an example of a question on area for which the results were rated as *marginal*.

Question 64

The diagram below shows a circle inside a square with sides 4 cm long.



How much larger is the area of the square than the area of the circle? (use $\pi = 3.14$)

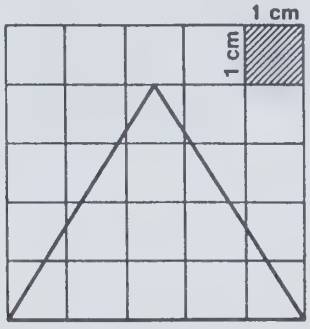
Student Responses

7%	A) 28.56 cm^2
19%	B) 16 cm^2
28%	C) 12.56 cm^2
*43%	D) 3.44 cm^2
3%	omit

The results for question 107 (reproduced below) were rated as *satisfactory*; students were able to obtain the area of the triangle by counting squares and portions of squares.

Question 107

Each small square in the diagram below has an area of 1 cm^2.



What is the area of the triangle shown above?

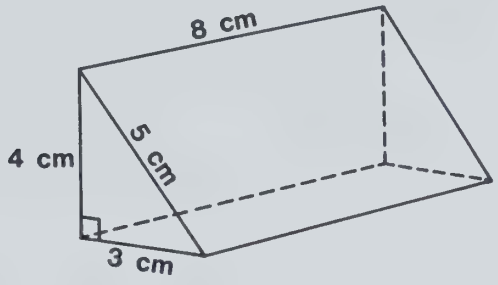
Student Responses

18%	A) 7 cm^2
*65%	B) 10 cm^2
10%	C) 15 cm^2
7%	D) 20 cm^2
1%	omit

The results for the questions on volume were rated as *marginal* on two questions and as *satisfactory* on one. The results for both questions on surface area were rated as *weak*. Question 105 (reproduced below) is one of these questions. The interpretation panel felt that the questions on volume may not be representative of how volume is taught in Grade 8 mathematics.

Question 105

The dimensions of a triangular prism are shown in the diagram below.



What is the surface area of this triangular prism?

Student Responses

31%	A) 120 cm^2
*22%	B) 108 cm^2
30%	C) 96 cm^2
14%	D) 76 cm^2
3%	omit

The results for the five questions on metric units were rated as *strong* on two questions, *satisfactory* on one question, and *weak* on two.

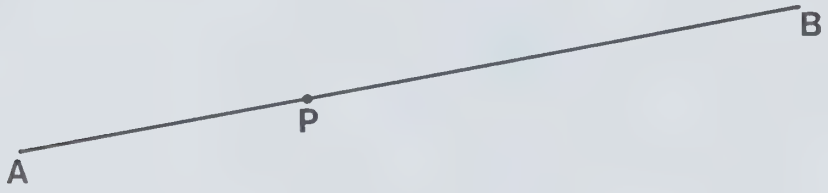
Constructions

There were fourteen questions on this topic and the panel rated the results as *marginal*. Student achievement on eight questions was rated as *marginal*, on two as *satisfactory*, and on four as *weak*.

Seven questions were multiple choice and seven required students to draw constructions in the test booklet. Five questions asked for the construction of a figure. The results on four were rated as *marginal* and on one as *weak*. Three questions asked for the construction of a line with specified properties. The results for all three questions were rated as *weak*. The results for questions 38 and 76 (reproduced below) were rated as *weak* and *marginal*, respectively.

Question 38

Construct a line through P perpendicular to AB.



Question 38 was answered correctly by 45 per cent of students.

Question 76

Complete the construction of parallelogram ABCD.

Question 76 was answered correctly by 51 per cent of students. The interpretation panel felt that there may have been inconsistencies in the marking of this question.

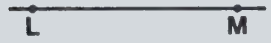
Two questions required students to bisect a line and an angle; results were rated as *weak* and *marginal*, respectively. Three questions involved congruence; results were rated as *satisfactory* on one question and as *marginal* on two. The results for question 72 (reproduced below) were rated as *satisfactory*.

Question 72

Which line segment is congruent to line segment PQ?

A)

B)

C) 

D)

Student Responses

2% A)

3% B)

12% C)

*81% D)

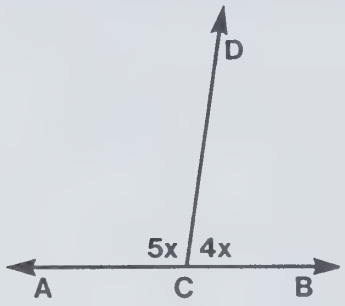
1% omit

Properties of Plane Figures

There were fifteen questions on this topic and the panel rated the results as *satisfactory*. Student achievement was rated as *satisfactory* on ten questions, as *strong* on one question, as *marginal* on three questions, and as *weak* on one. Ten of the questions involved angle properties in triangles and in intersecting lines. Question 181 (reproduced below) is the question with a rating of *strong*.

Question 181

AB is a straight line.



What is the measure in degrees of angle BCD?

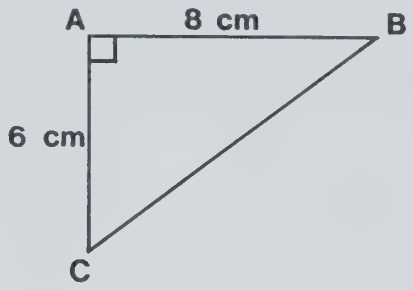
Student Responses

8%	A) 20
3%	B) 40
3%	C) 50
*77%	D) 80
8%	E) 100
1%	omit

Question 113 (reproduced below) measured ability to apply the Pythagorean theorem; the results were rated as *satisfactory*. The results for the other question on the Pythagorean theorem were rated as *marginal*.

Question 113

The lengths of two sides are given for the triangle below.



The length of BC is:

Student Responses

18%	A) 7 cm
*57%	B) 10 cm
18%	C) 14 cm
5%	D) 100 cm
1%	omit

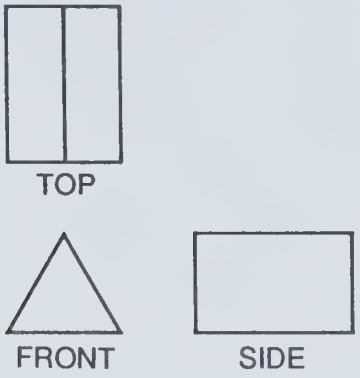
Three-Dimensional Geometry

There were ten questions on this topic and the panel rated the results as *strong*. Student achievement was rated as *superior* on two questions, *strong* on three questions, *satisfactory* on three questions, *marginal* on one question, and *weak* on one. The interpretation panel indicated that concrete materials rather than symbolic representation should be stressed in this area. Panel members felt that many students may have had difficulty interpreting the visual representations and that vocabulary may also have caused some difficulty. On average, 47 per cent of teachers indicated that they had taught the concepts required to answer the questions on this topic. Most of those who had not taught the concepts said that they had planned to teach them later in the school year.

Five questions required students to recognize properties of objects. Student performance was rated as *superior* on one of these questions, *strong* on two, and *satisfactory* on two. Question 33 (reproduced below) is one of the questions for which the results were rated as *satisfactory*.

Question 33

The front, top, and side views of a three-dimensional object are given below.



What type of object could be represented by these views?

Student Responses

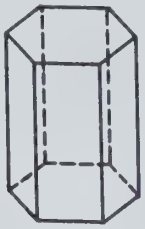
11%	A) tetrahedron
17%	B) triangular pyramid
*58%	C) triangular prism
13%	D) trapezoid
1%	omit

Question 73 (reproduced below) is one of the questions with a rating of *superior*.

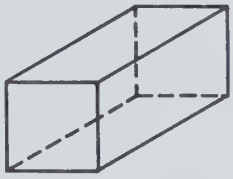
Question 73

Which drawing represents a hexagonal prism?

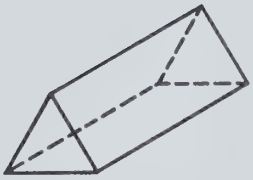
*89% A)



4% B)



5% C)



1% D)

1% omit

Transformations

There were fourteen questions on this topic and the panel rated the results as *marginal* to *satisfactory*. Student achievement was rated as *strong* on two questions, *satisfactory* on four questions, *marginal* on five, and *weak* on three. On average, 35 per cent of teachers indicated that they had taught the concepts required to answer the questions on this topic. Approximately half of the teachers said that they had planned to teach the concepts later in the school year, and about 15 per cent indicated other reasons for not teaching them.

Question 153 (reproduced below) is an example of a question with a rating of *strong*.

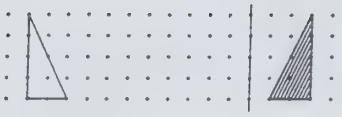
Question 153

The diagram below shows a figure and its reflected image.

Which diagram below shows the reflection line for the figure and its image?

3% A)

*86% B)

5% C) 

4% D)

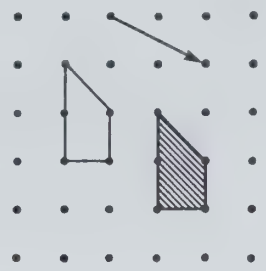
1% omit

Question 152 (reproduced below) is an example of a question with a rating of *weak*.

Question 152

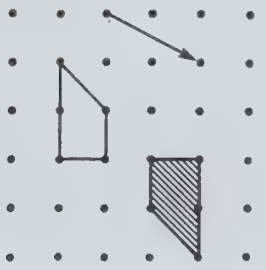
Which picture below shows the image of a quadrilateral under a given translation shown by the arrow?

*40% A)

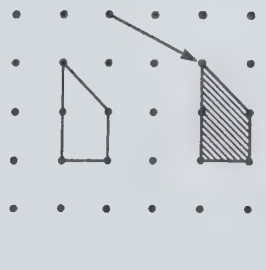


11% B)

19% C)



28% D)



3% omit

8.3 Process Problems

The eight questions on this topic assessed students' ability to apply problem-solving strategies to non-routine problems. When faced with a novel situation in problems such as these, the problem solver must find a solution through the use of general strategies such as trial and error, searching for a pattern, constructing a table, assuming a solution and working backward, and using a formula or equation. Students may have to experiment in order to find the combination of numbers that satisfies the specified conditions in the problem. The results for the process problems are presented in Table D-14 in Appendix D, and the strategies used by students to solve each problem are summarized in Table D-15.

The mean percentage correct for the eight problems was 36, and student performance was rated as *weak*. The results were rated as *weak* for four questions, *marginal* for three questions, and *satisfactory* for one question.

The interpretation panel felt that reading may have been a problem for some students. Student achievement on question 39 (reproduced below) was given a *satisfactory* rating; 61 per cent of students answered it correctly.

Question 39

Peter and Juanita decided to start saving money. Peter can save 3 dollars each month and Juanita can save 5 dollars each month. At this rate, after how many months will Juanita have exactly 10 dollars more than Peter?

Student Responses

*61% right
23% wrong
16% omit

Forty per cent of students used an organized table to solve the problem, and 14 per cent used an algebraic solution.

Student performance was rated as *marginal* on question 119 (reproduced below); 41 per cent of students obtained the correct answer.

Question 119

You have twelve coins totalling $1.65. If your coins are dimes and quarters, how many dimes do you have?

Student Responses

41% right
43% wrong
16% omit

Seventeen per cent of students used a guess-and-check procedure to solve the problem, 10 per cent used an organized table, 8 per cent used diagrams, and 17 per cent used some other strategy. Twenty per cent gave an answer only, and 16 per cent omitted the question.

Student performance was rated *weak* on question 80 (reproduced below); 21 per cent of students obtained the correct answer.

Question 80

John counted the legs of dogs and children at a dog show in the park. There were a total of 80 legs. If the difference between the number of children and the number of dogs was 1, how many dogs and children were there at the dog show?

Student Responses

21% right
45% wrong
34% omit

Nine per cent of students used a guess-and-check strategy to solve the problem, 5 per cent used an organized table, 6 per cent used an algebraic solution, and 16 per cent used some other strategy. Fifteen per cent gave an answer only, and 34 per cent omitted the question.

8.4 Calculator Questions

Students were not permitted to use calculators for the questions in the assessment booklets, but 12 questions for which students were permitted to use calculators were included in the Student Questionnaire. The results for these questions are presented in Table D-16 in Appendix D. The average percentage correct was 80, and student achievement was rated as *strong*.

Student achievement was rated as *superior* on two questions, *strong* on six questions, *satisfactory* on two questions, and *marginal* on two questions. Some of the questions are reproduced below. Student performance was rated as *superior* on question 52, *strong* on question 55, and *marginal* on question 60.

Question 52

The land areas of Canada's Atlantic Provinces are as follows:

Newfoundland	371 917 km^2
Prince Edward Island	5 678 km^2
Nova Scotia	53 045 km^2
New Brunswick	72 371 km^2

The total land area of Canada's Atlantic Provinces is:

Student Responses

1% A) 363 011 km^2
*95% B) 503 011 km^2
2% C) 663 011 km^2
2% D) 37 193 011 km^2

Question 55

In a skating competition, Judeen had the following scores for her free-style performance in artistic impression:

5.1	5.2	4.8	5.2	5.0	4.9	5.2	5.3

Which question below is best answered using a calculator?

Student Responses

4% A) What was her highest score?
4% B) Which score occurred most frequently?
*89% C) What was her average score?
2% D) How many scores were lower than 5.0?
1% omit

Question 60

To the nearest cent, what is 13.5% of $425?

Student Responses

8%	A)	$5.74
18%	B)	$55.25
*60%	C)	$57.38
12%	D)	$573.80
2%	omit	

8.5 Mental-Computation Questions

Twenty questions were presented orally, with only the numbers given visually, and students were not permitted to use paper and pencil to perform the calculations. The problems covered addition, subtraction, multiplication, division, applications of these operations in word problems, percentage, and conversions from one metric unit of measure to another. The results for each question are presented in Table D-17 in Appendix D.

The average percentage of correct answers for these questions was 63, and student achievement was rated as *marginal*. Student achievement was rated as *superior* for one question, *satisfactory* for six questions, *marginal* for seven questions, and *weak* for six questions. Examples of some mental-computation questions are given below.

Mental-Computation Questions

	Question	*Percentage Correct*	*Ratings*
1.	80 + 35 + 40 =	92%	superior
4.	What is the average of 26, 14, and 20?	64%	marginal
8.	6.5 ÷ 10 =	61%	marginal
9.	How many grams are there in 2.2 kg?	41%	weak
10.	$\frac{3}{5}$ of 45 =	42%	weak
13.	How many centimetres are there in 65 mm?	73%	satisfactory
16.	25% of 160 =	50%	weak
19.	How much interest would you earn on $1 000 in one year if the rate per year is 10%?	64%	marginal

8.6 Observation Activities

Several observation activities were included in the review. They were designed to discover what students can do when they are placed in a situation that calls for practical applications. Teachers observed students working individually with materials and recorded their observations. It is more effective to assess certain aspects of student performance through observation than by having students record answers in a booklet. In performing the observation tasks, students demonstrated basic knowledge and skills, resourcefulness and adaptability to different situations, the ability to respond to cues, self-reliance in solving practical problems, and the ability to manipulate materials.

The activities were presented in six observation booklets. The teacher administered each booklet to two randomly selected students in each class. An overall average score was not computed for these tasks. The panel rating for student performance on the observation activities was *satisfactory*.

Each task is discussed below; the detailed results for each task are presented in Table D-19 in Appendix D.

Geometric Constructions

Students were asked to construct a 45° angle, given a ruler, pencil, compasses, paper, and transparent mirror. Sixty-nine per cent of students were able to construct the angle. Nearly half of the students used ruler and compasses to construct the angle, 7 per cent used the transparent mirror, and 4 per cent used paper folding. Students were then asked to construct the angle using a different procedure. Twenty per cent were not able to complete the task.

Students were asked to construct a triangle with sides 4 cm, 5 cm, and 6 cm, given paper, pencil, ruler, compasses, and tracing paper. Eighty-two per cent of students were able to construct the triangle. Half of the students used a ruler only, and one-third of the students used a ruler and compasses. Student performance was rated as *satisfactory* for the construction of the angles, and *strong* for the construction of triangles.

Circle Graph

Students were asked to construct a circle graph to represent how a sum of money was spent, given the percentage of money spent on each of four items. Students could use a protractor, compasses, ruler, work paper, calculator, and pencil. More than 80 per cent drew a circle graph and used appropriate labels. Fifty-three per cent constructed the sectors correctly, and 34 per cent used an appropriate title. Fifty-five per cent of students calculated the number of degrees required for each sector and used a protractor to draw the sectors, and 32 per cent estimated the size of the sectors. Student performance was rated as *satisfactory* for the construction of the graph.

Use of Calculators

Students were asked to do a number of operations and to demonstrate a number of functions. Ninety-eight per cent of students entered a number correctly, and 95 per cent cleared the display before entering a second number. When informed of a change in the middle of a calculation, 44 per cent of students correctly cleared the last entry only and continued. Forty-one per cent cleared all entries and started over.

Eighty-two per cent of students were able to add two numbers and subtract a third. Thirty-four per cent of students were able to find the sum of two products; 21 per cent correctly used the memory keys for this sequence of operations. Fifty-three per cent of students were able to find 15 per cent of 47.

Student performance was rated as *strong* for entering a number, *satisfactory* for the addition and subtraction sequence, *weak* for the sum of products and the use of memory keys, and *marginal* for the operation involving percentage.

Measurement of Area

Students were shown a rectangle and a squared acetate sheet and were asked to estimate the area of a rectangle that was 80 cm^2. Sixty-one per cent of students estimated the area to within 10 cm^2 of the actual area. Students were then given a ruler and asked to calculate the area of the rectangle. Eighty-seven per cent of students calculated the area correctly. Sixty-four per cent measured the sides and used the formula, and 32 per cent used the acetate sheet. Student performance was rated as *marginal* for the estimation of area and *strong* for the calculation of area.

Measurement of Length

Students were given a string that was 140 cm long and asked to estimate its length. Forty per cent of students estimated the length to be in the range 110 cm to 170 cm. Fifty-five per cent of students estimated the length by comparing it with an object of known length; 43 per cent guessed. When students were asked to measure the length of the string with a metre stick, 92 per cent measured the length to within 5 cm. Student performance was rated as *marginal* for the estimation of length and *strong* for the measurement of length.

Estimating Quantity

In this activity students were shown a sheet containing seventy-nine circles placed in a disorganized arrangement. They were given fifteen seconds to estimate the numbers of circles. Forty-three per cent of students estimated the number to be between 70 and 90, and 30 per cent estimated the number to be in the range 60-69 or 91-100. Thirty-six per cent of students counted the circles until time was up and then estimated the number of remaining circles; 23 per cent counted the circles on half of the page and multiplied by two. Student performance was rated as *marginal* on this activity.

8.7 Opportunity to Learn

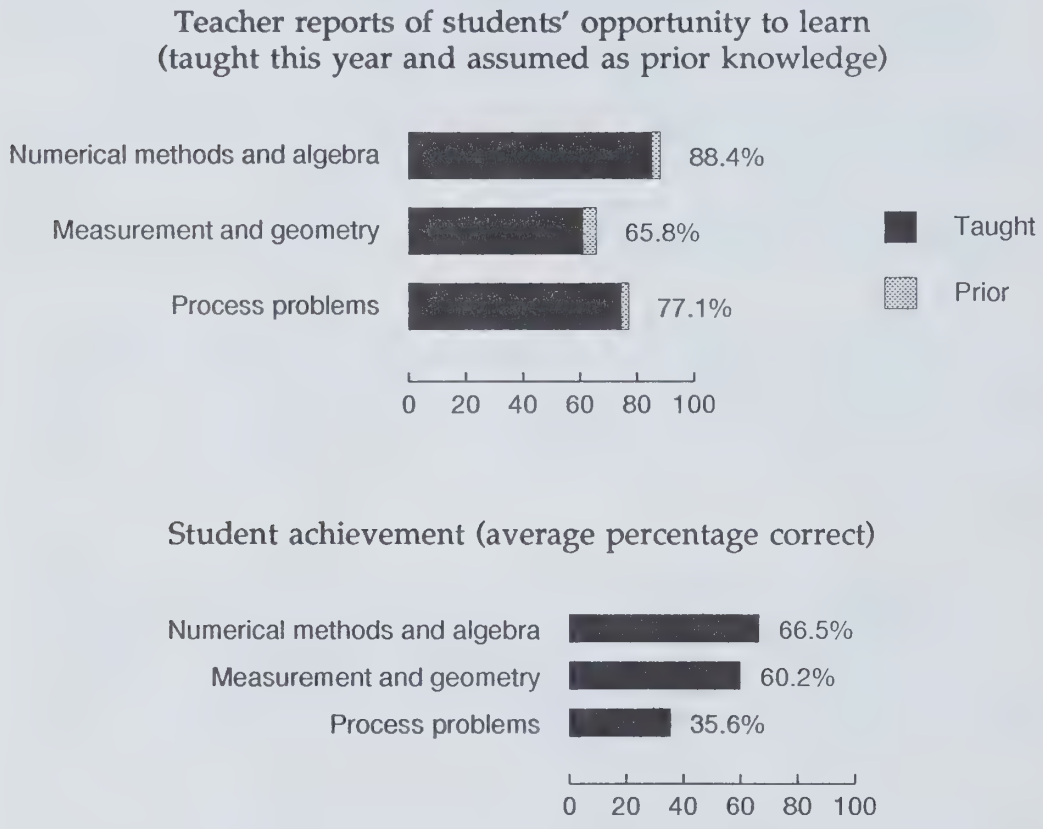
Teachers were asked to indicate whether or not they had taught the content required to answer each question in numerical methods and algebra, measurement and geometry, and process problems. The results for each question are presented in Tables D-1 to D-14 in Appendix D, and the summary data for each curriculum area are provided in Table D-20.

The results for opportunity to learn and the actual student achievement are summarized in the graphs in Figure 13. The graph for opportunity to learn shows the percentage of teachers who said that they taught the concepts or thought that the concepts had been taught in a prior year. These are the average percentages for all questions in each topic.

The highest opportunity to learn was for numerical methods and algebra; the lowest was for measurement and geometry. The achievement levels do not reflect these differences. Student achievement was very low for process problems although most of the teachers said that they taught these types of problems.

Figure 13

Summary of Results for Opportunity to Learn (OTL) and Achieved Percentage Correct



9. Summary and Conclusions

This comprehensive review of the Grade 8 mathematics program in Ontario generated a wealth of information on student achievement, student attitudes, program planning, teaching resources and practices, and the context within which the program is delivered. A detailed examination of the information at the provincial, school board, and school levels will provide guidance on how to maintain existing strengths and how to generate improvement in areas where weaknesses were identified.

9.1 Student Achievement

Grade 8 students in Ontario achieved at levels that were rated as *satisfactory* or better for more than half of the curriculum areas. The strongest student performance was in the topics of three-dimensional geometry, organization and representation of data, and calculator skills. Student performance was judged to be *satisfactory* to *strong* in whole numbers and decimals.

Student performance in the following areas was judged to be *satisfactory*: factors, powers, and square roots; ratio and rate; variables, formulas, and equations; properties of plane figures; and observation activities. Achievement was rated as *marginal* to *satisfactory* in geometric transformations, and a *marginal* rating was given to student achievement in per cent, integers, measurement, geometric constructions, and mental computation. Achievement was rated as *weak* in fractions and process problems.

Teachers reported that students had the opportunity to learn the course content required to answer most of the questions in the Student Assessment Booklets. Opportunity to learn was highest for numerical methods and algebra and lowest for measurement and geometry.

9.2 Student Attitudes

Most students expressed positive attitudes towards mathematics. Ninety-four per cent thought that mathematics was important for employment, 84 per cent said that mathematics helps them outside of school, and 96 per cent thought it was of equal importance for boys and girls. Sixty-three per cent of students felt that they were good in mathematics, and 20 per cent felt that mathematics was difficult. Sixty-seven per cent of students liked mathematics. The mathematics topics

that were liked by more than 50 per cent of students were whole numbers, fractions, and decimals; per cent; graphs; measurement; and problem solving. When given a difficult problem, most students attempted a variety of approaches to reach a solution; few students gave up before reaching a solution.

9.3 Classroom Activities and Classroom Practices

The most commonly used methods of instruction were chalkboard or projector presentations to the whole class and having students work individually on assignments. These activities accounted for over 72 per cent of class time. Teacher demonstrations with concrete materials were used for an average of 15 per cent of class time.

Seventy-three per cent of teachers said that calculators were used in almost every class or during about half of the classes. Forty-eight per cent said that calculators were also used for tests. Sixty-seven per cent of teachers reported that students had access to computers. When computers were available, teachers most frequently encouraged students to use them to practise new concepts, to learn new concepts and skills, and as an aid in doing projects.

Most students reported that they frequently worked on mathematics alone and that their teacher frequently taught mathematics to the whole class. Fifty-six per cent of students never did projects in mathematics, and most students never used a computer in mathematics class. Fifty-one per cent of students had computers at home, but only 9 per cent used them for mathematics school work.

Twenty-six per cent of students did more than one hour of mathematics homework per week, 46 per cent did one-half to one hour, 23 per cent did less than half an hour, and 5 per cent did no mathematics homework.

It is hoped that this report will encourage discussion about mathematics in Ontario schools. Ontario educators should now take steps to:

- maintain the strengths that were identified by this review of the Grade 8 mathematics program;
- recommend and implement procedures that will lead to improvement in areas where weaknesses were identified.

Appendix A: Principal Questionnaire

The percentage of principals selecting each response for each question on the Principal Questionnaire is presented in this appendix. The percentages are based on the number of principals answering a specific question.

Many questions on this questionnaire asked for information about all three grade levels (Grades 8, 10, and 12). Only the data for Grade 8 are reported in this appendix. Questions 3 and 4, which apply to Grades 10 and 12, have been omitted.

If a large number of numerical responses was possible for a given question, these have been grouped into categories. The data for these questions represent the percentage of principals giving responses that fall in each category. The average of all responses is also given.

Question 1, concerning the number of students enrolled in the school, is an example of this type of question. The first category is 0-149 students. In the province, 10 per cent of principals said that there were fewer than 150 students enrolled in their schools; 11 per cent of principals said that there were 550 or more students enrolled in their schools. The average number of students in all schools in the province is 357.

1. How many students are enrolled in your school?

No. of Students	*% of Principals*	
0-149	10%	Average
150-249	18%	number of
250-349	22%	students: 357
350-449	20%	
450-549	19%	
550 or more	11%	

N = 96

2. How many students are enrolled in Grade 8 mathematics?
(Include both semesters if applicable.)

No. of Students	*% of Principals*	
0-9	3%	Average
10-19	16%	number of
20-39	33%	students: 53
40-59	16%	
60-99	16%	
100 or more	14%	

N = 97

Note: Questions 3 and 4 apply only to Grades 10 and 12.

5. What is the time allocation for mathematics instruction in your school?

No. of Hours per Year	*% of Principals*	
0-114	6%	Average
115-124	48%	number of
125-134	15%	hours: 142
135-174	18%	
175 or more	13%	

N = 87

6. Which of the following best describes the community served by your school?

Urban/suburban area	64%
Rural area	34%
Isolated area	2%

N = 97

7. Which of the following applies to the scheduling of your mathematics program?

Full year	99%
Semestered	1%
Other	0%
Both	0%

N = 98

8. a) Is there an Immersion French or Extended French program in your school?

Yes	14%
No	86%

N = 97

b) If Yes, is Grade 8 mathematics taught in French?

Yes	50%
No	50%

N = 14

9. About how often do teachers in your school meet for the purpose of discussing the teaching of mathematics?

Once every week	6%	
Once every two or three weeks	5%	
Once every month or second month	18%	
Fewer than 5 times per year	52%	
Never	15%	
Only one teacher in the school	3%	N = 93

10. How much emphasis is placed on the following planning documents for mathematics?

	None	*Some*	*A Lot*	
Ministry of Education guidelines	4%	54%	42%	N = 97
School board documents	8%	27%	65%	N = 97
School-level planning documents/course of study	11%	35%	55%	N = 95

11. Does your school board have a procedure for regularly reviewing mathematics programs?

Yes	70%	
No	30%	N = 92

12. Does your school have a procedure for regularly reviewing mathematics programs?

Yes	43%	
No	57%	N = 92

13. When was the mathematics program last reviewed by either the school or the school board?

Has not occurred	14%	
Last school year (1988-89)	31%	
Two to four years ago	33%	
Five years or more	22%	
Currently	0%	N = 94

14. If a mathematics review was conducted, which of the following components did it include?

	Yes	*No*	
Review of planning documents	87%	13%	N = 71
Review of teaching practices	69%	31%	N = 67
Review of evaluation practices in schools	81%	19%	N = 68
Review of resources	88%	12%	N = 69
Administration of achievement test	47%	53%	N = 62

15. What changes occurred as a result of the last review of the mathematics program?

	Yes	*No*	
There was a change in:			
Teaching objectives	78%	22%	N = 69
Sequence and timing of programs	78%	22%	N = 69
Teaching strategies	82%	18%	N = 67
Student evaluation practices	66%	34%	N = 68
School resources	74%	26%	N = 68

16. Outside of regular professional development days, what activities or courses do teachers in your school engage in for the purpose of professional development for the teaching of mathematics?

	Yes	*No*	
Seminars/workshops	76%	24%	N = 94
Visiting other classrooms	49%	51%	N = 86
Conferences	52%	48%	N = 87
Peer coaching/job shadowing	35%	65%	N = 81
Credit courses	17%	83%	N = 78
Professional reading	70%	30%	N = 89

Appendix B: Teacher Questionnaire

The percentage of teachers selecting each response for each question on the Teacher Questionnaire is presented in this appendix. The percentages are based on the number of teachers answering a specific question. The number of respondents is given for each question.

If a large number of numerical responses was possible for a given question, these have been grouped into categories. The data for these questions represent the percentage of teachers giving responses that fall in each category. The average of all responses is also given. Question 19, which is reproduced below, is an example of this type of question.

---

19. What percentage of time is devoted to the problem-solving process?

% of Time	*% of Teachers*		
0-19%	9%	Average	
20-29%	25%	percentage	
30-39%	24%	of time:	35%
40-49%	16%		
50-59%	12%		
60% or more	13%		

N = 165

In the province, 9 per cent of teachers said that they spent less than 20 per cent of their class time on the problem-solving process in mathematics; 13 per cent of teachers said that they spent 60 per cent or more of their class time on problem solving. The average percentage of time spent on problem solving by teachers in the province was 35 per cent.

Section 1: PERSONAL/PROFESSIONAL BACKGROUND

1. **Are you male or female?**

Male	60%	
Female	40%	N = 169

2. **How many years' full-time teaching experience do you have?** ***(Include the current year and round to the nearest year any part-time experiences you have.)***

1 year	5%	
2 to 5 years	8%	
6 to 10 years	10%	
11 or more years	77%	N = 168

3. **How many years have you spent teaching mathematics?** ***(Include the current year and round to the nearest year any part-time experiences you have.)***

	Elementary	*Secondary*
1 year	12%	18%
2 to 5 years	10%	25%
6 to 10 years	16%	7%
11 or more years	62%	50%
	N = 153	N = 28

4. **How many full-year courses in mathematics methods were included in your teacher education?**

No instruction in mathematics methods	12%	
Some instruction as part of a general course	31%	
One full course in mathematics methods	50%	
Two or more full courses in mathematics methods	7%	N = 167

5. **How many full-year university courses do you have in mathematics?**

Zero	60%	
One	20%	
Two	11%	
Three	5%	
Four	1%	
Five or more	4%	N = 168

6. **How many courses in measurement and evaluation or testing were included in your teacher training and/or graduate courses?**

Zero	41%	
One	38%	
Two	13%	
Three or more	9%	N = 167

7. **Have you received training on the instructional use of computers with respect to the teaching of mathematics?**

Yes	22%	
No	78%	N = 169

Section 2: TEACHING PRACTICES

8. What importance do you place on the instruction of the following topics?

	Not Important	*Important*	*Very Important*	
Whole numbers and decimals	0%	14%	86%	N = 170
Factors, powers and square roots	4%	66%	30%	N = 170
Fractions and decimals	2%	35%	63%	N = 170
Ratio and rate	4%	47%	49%	N = 170
Per cent	2%	20%	78%	N = 170
Integers	7%	60%	34%	N = 169
Organization and representation of data	4%	54%	41%	N = 169
Variables, formulas, and equations	2%	46%	52%	N = 168
Measurement	2%	37%	61%	N = 169
Constructions	13%	69%	18%	N = 169
Properties of plane figures	21%	67%	12%	N = 165
Three-dimensional geometry	20%	69%	10%	N = 167
Transformations	35%	58%	7%	N = 170
Calculator skills	7%	54%	39%	N = 170
Problem solving	1%	6%	94%	N = 170

9. How much time per week outside of class do you think that the average student in your class will take to complete his/her mathematics homework assignments?

Less than 1 hour	29%	
1 to 2 hours	49%	
Between 2 and 3 hours	17%	
3 hours or more	5%	N = 170

10. Do your students of mathematics have access to computers?

Yes	67%	
No (Go to Question 13)	33%	N = 166

11. Approximately what percentage of time do your mathematics students spend using computers per week?

% of Time	*% of Teachers*			
0-4% of time	36%	Average		
5-9% of time	29%	percentage		
10-14% of time	20%	of time:	7%	
15-19% of time	5%			
20% or more	11%			N = 101

12. Do you encourage your mathematics students to use computers to do any of the following?

	Yes	*No*	
To check answers to exercises	16%	84%	N = 102
To practise new concepts	64%	36%	N = 102
To learn new concepts and skills	43%	57%	N = 102
To take tests	5%	95%	N = 102
As an aid to do projects	52%	48%	N = 104

13. In your mathematics classes how often are calculators used?

Often (during every or almost every class)	33%	
Occasionally (during about half the lessons)	40%	
Rarely	26%	
Never	1%	N = 169

14. Do you encourage your mathematics students to use calculators to do any of the following?

	Yes	*No*	
To check answers to exercises	89%	11%	N = 168
To practise new concepts	60%	40%	N = 163
To learn new concepts and skills	52%	48%	N = 160
For use during tests	48%	52%	N = 155
As an aid to do projects	75%	25%	N = 162

15. How much emphasis is placed on each of the following in preparing lessons in mathematics?

	Not Available	*None*	*Some*	*A Lot*	
Ministry of Education guideline	3%	12%	54%	31%	N = 168
Board materials	8%	6%	44%	41%	N = 169
Textbook or teacher's edition of textbook	0%	0%	23%	77%	N = 170
Materials prepared by yourself or other teachers in your school	2%	7%	56%	35%	N = 168
Journals or other teacher reference books	11%	33%	54%	2%	N = 169
Commercially produced supplementary materials	6%	16%	73%	5%	N = 168
Materials from teacher education courses	12%	47%	38%	2%	N = 169
Materials from your in-service workshops, conferences, and seminars	6%	24%	64%	6%	N = 169
Suggestions from students	3%	34%	60%	3%	N = 168

16. What percentage of time during the school year do you use each of the following methods or aids for the teaching of mathematics? *(The percentages should total 100%.)*

A chalkboard and/or projector presentation to the class

% of Time	*% of Teachers*			
0-24%	16%	Average		
25-49%	45%	percentage		
50-74%	27%	of time:	43%	
75% or more	13%			N = 166

Teacher demonstration with concrete materials to the class

% of Time	*% of Teachers*			
0-4%	2%	Average		
5-9%	19%	percentage		
10-19%	42%	of time:	15%	
20-29%	28%			
30% or more	8%			N = 165

Students working cooperatively in groups

% of Time	*% of Teachers*			
0-4%	4%	Average		
5-9%	10%	percentage		
10-19%	34%	of time:	21%	
20-29%	28%			
30% or more	24%			N = 165

Students working individually

% of Time	*% of Teachers*			
0-9%	8%	Average		
10-19%	21%	percentage		
20-29%	27%	of time:	29%	
30-39%	18%			
40% or more	26%			N = 165

Note: The sum of the four percentages specified by teachers was often greater than 100%. Therefore, the sum of the four averages may be greater than 100%.

17. Which of the following materials do you have access to during the teaching of mathematics?

	Yes	*No*	
Blackline masters (photocopy masters)	83%	17%	N = 170
Commercially produced audio-visual materials	51%	49%	N = 168
Dot paper/grid paper	98%	2%	N = 170
Semitransparent mirror	54%	46%	N = 170
Geoboards	56%	44%	N = 169
Pattern blocks, geometric solids	68%	32%	N = 167
Geometry set	94%	6%	N = 170
Student-generated materials	57%	43%	N = 162
Textbooks	99%	1%	N = 170

18. How much emphasis do you place on each of the following in your mathematics class?

	None	*Some*	*A Lot*	
Blackline masters (photocopy masters)	19%	73%	8%	N = 167
Commercially produced audio-visual materials	52%	47%	1%	N = 167
Dot paper/grid paper	5%	85%	11%	N = 168
Semitransparent mirror	52%	47%	1%	N = 168
Geoboards	58%	41%	1%	N = 168
Pattern blocks and geometric solids	35%	61%	4%	N = 168
Geometry set	5%	68%	28%	N = 170
Student-generated materials	40%	55%	4%	N = 164
Textbooks	2%	15%	83%	N = 169

19. What percentage of time is devoted to the problem-solving process?

% of Time	*% of Teachers*			
0-19%	9%	Average		
20-29%	25%	percentage		
30-39%	24%	of time:	35%	
40-49%	16%			
50-59%	12%			
60% or more	13%			N = 165

20. Which of the following <u>best</u> describes the problem-solving component of your mathematics program?

I teach problem solving as a separate unit.	7%	
I integrate problem solving into the mathematics program throughout the year.	92%	
Both	2%	N = 169

21. What approaches do you use in teaching problem solving?

	Yes	*No*	
I provide students with many puzzles and problems to solve.	86%	14%	N = 164
I provide students with a systematic approach to solving problems (e.g. understand, plan, solve, look back).	97%	3%	N = 167
I teach specific strategies for solving problems (e.g. guess and check, make a list, draw diagram, etc.).	95%	5%	N = 165
I encourage students to develop their own strategies.	82%	18%	N = 165

22. How are the solutions to problems in mathematics dealt with by the students?

	Yes	*No*	
Students discuss their solutions with each other.	87%	13%	N = 165
Students report their results to the whole class.	84%	16%	N = 164
Students write up their solutions or the results of their discoveries and present them to the teacher.	81%	19%	N = 163

23. Do you use diagnostic pre-tests in your mathematics class?

Never	7%	
Sometimes	79%	
Often	14%	N = 169

24. On average, how often do you assess your students' learning of mathematics skills and concepts?

Less than once per month	1%
Once per month	14%
Twice per month	32%
Three times per month	16%
Four times per month or more	38%

N = 169

25. In mathematics, what per cent of the students' final mark is determined through the use of the following. ***(The total for the grade should add up to 100%.)***

	Percentage of Mark	*Percentage of Teachers*	*Average Percentage of Mark*	
Quizzes or short tests	0-9%	3%	31%	
	10-19%	15%		
	20-29%	36%		
	30-39%	16%		
	40-49%	8%		
	50% or more	22%		N = 157
Cumulative or end-of-unit tests	0-19%	8%	39%	
	20-29%	17%		
	30-39%	19%		
	40-49%	25%		
	50-59%	17%		
	60% or more	22%		N = 163
Formal examinations	0%	62%	7%	
	1-9%	5%		
	10-19%	12%		
	20-29%	10%		
	30% or more	10%		N = 112
Observation of student behaviour	0%	11%	14%	
	1-9%	7%		
	10-14%	40%		
	15-24%	29%		
	25% or more	14%		N = 152
Peer/self-evaluation	0%	38%	7%	
	1-9%	15%		
	10-14%	31%		
	15-24%	10%		
	25% or more	5%		N = 115
Others (projects, assignments, etc.)	0%	16%	13%	
	1-9%	12%		
	10-14%	36%		
	15-24%	21%		
	25% or more	16%		N = 135

Appendix C: Student Questionnaire

The percentage of students selecting each response is given for each question. The percentage of students omitting each question is also given. The percentages are based on the total number of students responding to the questionnaire in the province (4849).

1. Are you male or female?

50%	A) Male.
50%	B) Female.
0%	(omit)

2. In which year were you born?

1%	A) 1974 or before.
13%	B) 1975.
84%	C) 1976.
2%	D) 1977.
0%	E) 1978 or after.
0%	(omit)

3. What language do you most often speak at home?

89%	A) English.
1%	B) French
9%	C) Other.
0%	(omit)

4. On average how much time out of school do you spend watching TV programs each day?

3%	A) None at all.
15%	B) Up to 1 hour.
34%	C) Between 1 and 2 hours.
29%	D) Between 2 and 3 hours.
19%	E) More than 3 hours.
0%	(omit)

5. About how much time do you spend on mathematics homework each week?

5%	A) I don't do any mathematics homework.
23%	B) Less than 1/2 hour.
46%	C) 1/2 hour to 1 hour.
26%	D) More than 1 hour.
0%	(omit)

6. How often do you get help with mathematics from someone in your family?

47%	A) Never or almost never.
46%	B) Occasionally.
7%	C) Often.
0%	(omit)

DO YOU LIKE DOING MATHEMATICS QUESTIONS THAT DEAL WITH:

7. Whole Numbers, Fractions, and Decimals?

51%	A) Yes.
31%	B) No.
18%	C) I'm not sure.
0%	D) We do not do these kinds of questions.
0%	(omit)

8. Factors, Powers, and Square Roots?

43%	A) Yes.
39%	B) No.
17%	C) I'm not sure.
1%	D) We do not do these kinds of questions.
0%	(omit)

9. Ratio and Rate?

46%	A) Yes.
33%	B) No.
19%	C) I'm not sure.
2%	D) We do not do these kinds of questions.
0%	(omit)

10. Per Cent?

65%	A) Yes.
23%	B) No.
11%	C) I'm not sure.
1%	D) We do not do these kinds of questions.
0%	(omit)

11. Integers?

46%	A) Yes.
26%	B) No.
19%	C) I'm not sure.
9%	D) We do not do these kinds of questions.
0%	(omit)

12. Algebra?

40%	A) Yes.
25%	B) No.
19%	C) I'm not sure.
15%	D) We do not do these kinds of questions.
0%	(omit)

13. Graphs?

72%	A) Yes.
16%	B) No.
9%	C) I'm not sure.
3%	D) We do not do these kinds of questions.
0%	(omit)

DO YOU LIKE DOING MATHEMATICS QUESTIONS THAT DEAL WITH:

14. Measurement?

58%	A) Yes.
28%	B) No.
13%	C) I'm not sure.
1%	D) We do not do these kinds of questions.
0%	(omit)

15. Constructions in Geometry?

47%	A) Yes.
29%	B) No.
17%	C) I'm not sure.
7%	D) We do not do these kinds of questions.
0%	(omit)

16. Two-Dimensional Figures?

40%	A) Yes.
28%	B) No.
23%	C) I'm not sure.
10%	D) We do not do these kinds of questions.
0%	(omit)

17. Three-Dimensional Objects?

41%	A) Yes.
26%	B) No.
20%	C) I'm not sure.
12%	D) We do not do these kinds of questions.
0%	(omit)

18. Transformations?

23%	A) Yes.
22%	B) No.
29%	C) I'm not sure.
26%	D) We do not do these kinds of questions.
0%	(omit)

19. Problem Solving?

56%	A) Yes.
33%	B) No.
10%	C) I'm not sure.
0%	D) We do not do these kinds of questions.
0%	(omit)

The following questions ask about what you and your class do when you are learning mathematics. Think about what happens in your mathematics class.

20. How often do you do mathematics at the board or on the overhead projector?

31%	A) Almost every day.
14%	B) Once a week or so.
38%	C) Only once in a while.
17%	D) Never.
0%	(omit)

21. How often is mathematics presented to the whole class as a group?

84%	A) Almost every day.
5%	B) Once a week or so.
7%	C) Only once in a while.
4%	D) Never.
0%	(omit)

22. How often do you do mathematics in small groups?

16%	A) Almost every day.
9%	B) Once a week or so.
43%	C) Only once in a while.
31%	D) Never.
0%	(omit)

23. How often do you do mathematics on your own in class?

81%	A) Almost every day.
6%	B) Once a week or so.
9%	C) Only once in a while.
3%	D) Never.
0%	(omit)

24. How often do you do projects on mathematics topics?

2%	A) Almost every day.
4%	B) Once a week or so.
38%	C) Only once in a while.
56%	D) Never.
0%	(omit)

25. How often do you do projects in other subjects that involve the use of mathematics?

6%	A) Almost every day.
14%	B) Once a week or so.
63%	C) Only once in a while.
16%	D) Never.
0%	(omit)

26. How often do you write tests or quizzes in mathematics?

4%	A) Almost every day.
43%	B) Once a week or so.
52%	C) Only once in a while.
1%	D) Never.
0%	(omit)

27. How often do you use a calculator to do mathematics in class?

31%	A) Almost every day.
20%	B) Once a week or so.
37%	C) Only once in a while.
11%	D) Never.
0%	(omit)

28. How often do you use a computer to do mathematics in class?

1%	A) Almost every day.
3%	B) Once a week or so.
11%	C) Only once in a while.
86%	D) Never.
0%	(omit)

29. How often do you use a calculator for mathematics tests?

9%	A) Almost always.
14%	B) Frequently.
44%	C) Occasionally.
33%	D) Never.
0%	(omit)

30. Do you use a calculator at home?

17%	A) No.
13%	B) Yes, but not for mathematics schoolwork.
12%	C) Yes, for mathematics schoolwork only.
58%	D) Yes, for mathematics schoolwork and other things.
0%	(omit)

31. Do you have a computer at home?

49%	A) No.
12%	B) Yes, but I don't use it.
30%	C) Yes, I use it but not for mathematics schoolwork .
1%	D) Yes, I use it for mathematics schoolwork only.
8%	E) Yes, I use it for mathematics schoolwork and other things.
0%	(omit)

The following questions ask how you feel about the mathematics you are learning in school.

32. Do you think mathematics is:

2%	A) more for males than females?
1%	B) more for females than males?
96%	C) for everyone equally?
0%	(omit)

33. I like mathematics.

22%	A) Strongly agree.
45%	B) Agree.
18%	C) Not sure.
9%	D) Disagree.
5%	E) Strongly disagree.
0%	(omit)

34. Mathematics helps me outside of school.

34%	A) Strongly agree.
50%	B) Agree.
11%	C) Not sure.
4%	D) Disagree.
1%	E) Strongly disagree.
0%	(omit)

35. Learning mathematics is mostly memorizing.

15%	A) Strongly agree.
39%	B) Agree.
23%	C) Not sure.
19%	D) Disagree.
4%	E) Strongly disagree.
0%	(omit)

36. I am good at mathematics.

19%	A) Strongly agree.
44%	B) Agree.
23%	C) Not sure.
10%	D) Disagree.
4%	E) Strongly disagree.
0%	(omit)

37. It is important to know mathematics in order to get a good job.

68%	A) Strongly agree.
26%	B) Agree.
4%	C) Not sure.
2%	D) Disagree.
1%	E) Strongly disagree.
0%	(omit)

38. Mathematics is difficult for me.

5%	A) Strongly agree.
15%	B) Agree.
20%	C) Not sure.
39%	D) Disagree.
21%	E) Strongly disagree.
0%	(omit)

39. When I do problems in mathematics, I usually have trouble understanding what the sentences say.

4%	A) Strongly agree.
13%	B) Agree.
19%	C) Not sure.
45%	D) Disagree.
20%	E) Strongly disagree.
0%	(omit)

40. There are usually different ways to solve mathematical problems.

28%	A) Strongly agree.
57%	B) Agree.
12%	C) Not sure.
2%	D) Disagree.
1%	E) Strongly disagree.
0%	(omit)

WHEN YOU DON'T UNDERSTAND A PROBLEM IN MATHEMATICS DO YOU:

41. Try different ways to solve it on your own?

40%	A) Often.
56%	B) Sometimes.
4%	C) Never.
0%	(omit)

42. Ask another student for help?

25%	A) Often.
68%	B) Sometimes.
7%	C) Never.
0%	(omit)

43. Ask your teacher for help?

21%	A) Often.
68%	B) Sometimes.
10%	C) Never.
0%	(omit)

44. Wait and ask someone at home?

6%	A) Often.
41%	B) Sometimes.
52%	C) Never.
0%	(omit)

45. Just give up?

4%	A) Often.
37%	B) Sometimes.
58%	C) Never.
1%	(omit)

Appendix D: Mathematics Achievement

The results for all achievement items for Grade 8 mathematics are presented in this appendix.

1. Item Statistics for Student Assessment Booklets (D-1 to D-14).

Each table contains the results for the set of items dealing with one of the fourteen topics, eight in numerical methods and algebra, five in measurement and geometry, and the category of process problems. Within each table, the items are grouped according to level of complexity (recognition/recall, comprehension, and application). The items are identified by booklet number and item number. The set of questions for each topic precedes the table.

For multiple-choice questions, the key identifies the correct response, and the percentage of students selecting each response is given under columns *A, B, C, D,* and *E.* The percentage of students omitting each item is given under *O. OTL* represents the percentage of teachers who said that they taught the content covered by the question or that they felt it was taught in a previous year. *Cor* is the average percentage correct achieved by students. Some questions required students to write a response in the booklet, and these were marked correct or incorrect. For these questions, data are provided only for *O, OTL,* and *Cor.*

For multiple-choice questions, the percentages are based on the total number of students answering each booklet. For the province the numbers of students are as follows:

Booklet number:	1	2	3	4	5
Number of females:	504	507	482	472	494
Number of males:	465	466	481	487	442
Total number of students:	977	981	972	966	941

The total number is not equal to the sum of the numbers of females and males because some students did not specify gender.

For open-ended questions, a number of teachers did not record marks on the student answer sheets. The percentages reported for the item statistics are based on the total number of students for whom marks were recorded. This number of students is given below each table that contains data for open-ended questions. No data are reported for questions for which marks were recorded for fewer than 20 per cent of students who should have answered a given question. The number recorded under the *O* column is the percentage of students for whom teachers marked the no-response category. In Table D-14, the number of marked responses *(N)* is given for each question.

The conclusions of the interpretation panel are also provided. The acceptable level *(Acc)*, the desirable level *(Des)*, and the rating *(Rtg)* are given for each question. These terms have been discussed in "3.3 Interpretation of Results".

2. Strategies for Process Problems (D-15)

This table gives the percentage of students who used each strategy in obtaining solutions to process problems.

3. Calculator Questions and Mental-Computation Questions (D-16 and D-17)

The average percentage correct (*Cor*) for each question and the percentage of students omitting each question (*O*) are given. The percentage of students selecting each response is also given for the calculator questions.

4. Summary of Achievement by Topic (D-18)

This table presents a summary of the data for groups of questions by topic. Averages are provided for percentage correct and opportunity to learn. Average percentage correct is given for males, females, and the total student population.

Panel ratings are given for each content area. The reported acceptable (*Acc*) and desirable (*Des*) levels were obtained by averaging the levels assigned to each question. The rating (*Rtg*) was assigned to each topic through deliberations of the panel. Panel ratings are not provided for the cognitive levels.

5. Observation Booklets (D-19)

The percentage of students providing each response to the hands-on tasks observed by teachers is presented in Table D-19. The descriptions of student behaviours are given on the pages following the table.

6. Opportunity to Learn (D-20)

Teachers were asked whether or not they had taught the content required to answer each question in the Student Assessment Booklets. Results for each question are presented in Table D-20. The percentage of teachers who said that they taught the content is reported in the column *Taught*, and the percentage of teachers who said that the content was not taught is reported in four columns according to the reason for not teaching it (assumed taught in a prior year, intended to teach it later in the year, content not in the curriculum, and other reasons).

Numerical Methods and Algebra: Whole Numbers and Decimals

1. One year, the Toronto Blue Jays had a total attendance figure of 2 486 391. What digit is in the hundred-thousands place?

   A) 2
   B) 4
   C) 6
   D) 8

2. Calculate 34 + 30.6 + 47.08.

   A) 50.48
   B) 77.68
   C) 111.14
   D) 111.68

3. Choose the correct answer:
$$\begin{array}{r} 9.65 \\ \times\ 40.6 \\ \hline \end{array}$$

   A) 39.179
   B) 50.25
   C) 55.9
   D) 391.79

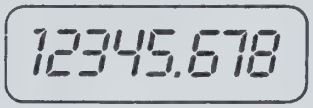
41. Which list has the numbers arranged from smallest to largest.

   A) 6.045, 6.45, 6.5
   B) 6.45, 6.5, 6.045
   C) 6.045, 6.5, 6.45
   D) 6.45, 6.045, 6.5

43. Choose the correct answer:
$$\begin{array}{r} 687 \\ \times\ 54 \\ \hline \end{array}$$

   A) 6 203
   B) 33 098
   C) 36 778
   D) 37 098

81. Here is a calculator display.



   Which digit is in the thousandths place?

   A) 8
   B) 6
   C) 2
   D) 1

82. Calculate 6.688 ÷ 0.38.

   A) 0.176
   B) 1.76
   C) 17.6
   D) 176

83. Which symbol (+, −, ×, ÷) must replace the box to make a true statement?

   (4+6) ☐ 2 − 5 = 0

   A) +
   B) ÷
   C) ×
   D) −

122. Calculate 18 − 4.87.

   A) 4.69
   B) 13.13
   C) 14.13
   D) 14.23

123. Choose the correct answer: $73\overline{)4\ 088}$

   A) 56
   B) 58
   C) 560
   D) 580

161. The expression 0.40 × 6.38 is equal to:

   A) 0.2552
   B) 2.452
   C) 2.552
   D) 24.52
   E) 25.52

Whole Numbers and Decimals (cont'd)

192. Look at the figure below.

The position on the scale indicated by the arrow is:

A) 1.004
B) 1.04
C) 1.08
D) 1.4
E) 1.8

42. The first Canadian Prime Minister was Sir John A. Macdonald. He was born in Scotland in 1815. How many years ago was he born?

A) 125
B) 175
C) 185
D) 1 085

121. Ronald bought the following items:

Box of computer disks	$ 8.50
Computer magazine	$ 8.98
Joystick	$ 39.75

The best estimate of the total of Ronald's purchases, excluding sales tax, is:

A) $70.00
B) $50.00
C) $60.00
D) $40.00

168. Joe had three test scores of 78, 76, and 74, while Mary had scores of 72, 82, and 74. How did Joe's average compare with Mary's?

A) Joe's average was 1 point higher.
B) Joe's average was 1 point lower.
C) Both averages were the same.
D) Joe's average was 2 points higher.
E) Joe's average was 2 points lower.

Table D-1
Numerical Methods and Algebra: Whole Numbers and Decimals

										Panel Rating		
Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Acc*	*Des*	*Rig*
Comprehension	1-1	(B)	4	82	8	7		0	100	82	85	95	3
	1-2	(D)	4	3	9	84		0	100	84	80	90	3
	1-3	(D)	15	3	2	79		1	100	79	75	87	3
	2-41	(A)	81	7	4	8		1	99	81	75	90	4
	2-43	(D)	1	5	5	88		1	100	88	80	95	4
	3-81	(A)	69	6	23	1		0	100	69	82	95	2
	3-82	(C)	14	14	65	5		2	99	65	73	85	3
	3-83	(B)	2	84	6	6		2	99	84	78	92	4
	4-122	(B)	20	63	11	6		0	99	63	78	90	2
	4-123	(A)	81	9	6	2		1	100	81	80	92	3
	5-161	(C)	17	6	61	5	10	1	99	61	76	88	2
	5-192	(B)	6	66	2	23	1	1	80	66	70	85	3
Application	2-42	(B)	2	86	10	2		0	99	86	82	95	4
	4-121	(C)	5	10	84	1		0	99	84	81	91	4
	5-168	(C)	2	4	78	5	10	1	98	78	75	88	3

Factors, Powers, and Square Roots

4. The square root of 81 is:

A) 81
B) 9
C) 3
D) 2

5. The number 10 000 written as a power of ten is:

A) 10^2
B) 10^3
C) 10^4
D) 10^5

45. The value of $2^2 + 5^2$ is:

A) 14
B) 29
C) 49
D) 50

84. Which one of the following is a perfect square?

A) 39
B) 42
C) 49
D) 99

85. All the factors of 12 are:

A) 1, 2, 3, 4, 6, 12
B) 2, 4, 6, 12
C) 2, 3, 4, 6
D) 1, 12

124. The square of 5 is:

A) 55
B) 25
C) 10
D) 5

125. Which of the following is a prime number?

A) 99
B) 79
C) 69
D) 49

126. The expression $2 \times 2 \times 2 \times 3 \times 3$ is equal to:

A) $6 + 9$
B) $3 \times 2 \times 2 \times 3$
C) 12
D) $2^3 \times 3^2$

164. The value $2^3 \times 3^2$ is:

A) 30
B) 36
C) 64
D) 72
E) None of these

44. The number which is divisible by 2, 5, and 10 is:

A) 4 362
B) 5 890
C) 6 545
D) 7 304

86. The number which is divisible by 2, 3, and 5 is:

A) 62 654
B) 24 030
C) 14 320
D) 13 036

Table D-2
Numerical Methods and Algebra: Factors, Powers, and Square Roots

											Panel Rating		
Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Acc*	*Des*	*Rtg*
Comprehension	1-4	(B)	3	92	3	1		1	96	92	80	92	4
	1-5	(C)	3	24	66	7		0	97	66	82	90	2
	2-45	(B)	20	75	2	3		0	99	75	75	90	3
	3-84	(C)	3	38	42	13		3	95	42	77	90	1
	3-85	(A)	89	6	3	2		0	99	89	78	93	4
	4-124	(B)	2	79	6	13		1	99	79	86	97	3
	4-125	(B)	19	41	17	20		2	99	41	72	89	1
	4-126	(D)	2	2	1	95		0	100	95	79	89	5
	5-164	(D)	1	11	2	65	20	0	99	65	75	86	2
Application	2-44	(B)	6	76	14	2		3	98	76	83	95	3
	3-86	(B)	10	70	14	5		2	98	70	75	88	3

Fractions

6. Calculate $\frac{7}{8} - \frac{1}{4} - \frac{1}{2}$.

A) $\frac{1}{8}$

B) $\frac{9}{14}$

C) $\frac{5}{8}$

D) $\frac{5}{2}$

7. Calculate $\frac{3}{4} + \frac{2}{3}$.

A) $\frac{6}{12}$

B) $\frac{2}{4}$

C) $\frac{5}{7}$

D) $\frac{17}{12}$

8. The fraction $\frac{5}{8}$ written in decimal form is:

A) 1.6
B) 0.625
C) 0.58
D) 0.375

46. Calculate $\frac{2}{3} + \frac{3}{5}$.

A) $\frac{5}{2}$

B) $\frac{9}{10}$

C) $\frac{10}{9}$

D) $\frac{2}{5}$

47. Calculate $4\frac{1}{2} + \frac{3}{4}$.

A) $5\frac{1}{4}$

B) $5\frac{4}{6}$

C) $5\frac{1}{2}$

D) $5\frac{3}{8}$

48. The mixed fraction $2\frac{4}{5}$ as a decimal is:

A) 0.35
B) 0.8
C) 2.45
D) 2.8

88. Calculate $\frac{3}{4} \div 2$.

A) $\frac{3}{8}$

B) $\frac{3}{2}$

C) $\frac{6}{4}$

D) 3

118. Write $\frac{2}{3}$ as a repeating decimal.

127. Calculate $4 - \frac{2}{3}$.

A) $4\frac{2}{3}$

B) $4\frac{1}{3}$

C) $3\frac{1}{3}$

D) $\frac{2}{3}$

128. Calculate $\frac{8}{3} \times \frac{4}{3}$.

A) $\frac{32}{3}$

B) $\frac{12}{3}$

C) $\frac{32}{9}$

D) $\frac{12}{6}$

129. The fraction equal to 0.05 is:

A) $\frac{1}{20}$

B) $\frac{1}{5}$

C) $\frac{5}{10}$

D) $\frac{1}{2}$

162. The number $7\frac{3}{20}$ is equal to:

A) 7.03
B) 7.15
C) 7.23
D) 7.3
E) 7.6

166. Which of the following is a pair of equivalent fractions?

A) $\frac{3}{5}$ and $\frac{9}{15}$

B) $\frac{5}{6}$ and $\frac{2}{3}$

C) $\frac{4}{5}$ and $\frac{14}{15}$

D) $\frac{5}{8}$ and $\frac{2}{3}$

E) $\frac{1}{2}$ and $\frac{14}{24}$

167. The picture shows some black and some white marbles.

What fraction of the marbles is white?

A) $\frac{4}{10}$

B) $\frac{6}{10}$

C) $\frac{4}{6}$

D) $\frac{6}{4}$

E) $\frac{1}{2}$

87. Skates were on sale for $\frac{1}{3}$ off. The regular price was \$60.

How much was the sale price?

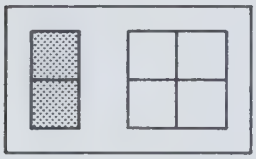
A) \$10
B) \$20
C) \$30
D) \$40

Table D-3
Numericals Methods and Algebra: Fractions

Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Panel Rating* *Acc*	*Des*	*Rtg*
Comprehension	1-6	(A)	64	4	11	19		1	98	64	75	85	2
	1-7	(D)	7	1	29	62		1	98	62	75	87	2
	1-8	(B)	8	48	39	4		0	99	48	75	85	1
	2-46	(C)	6	15	54	22		3	97	54	75	88	2
	2-47	(A)	66	18	7	9		1	98	66	70	88	3
	2-48	(D)	5	3	44	47		1	98	47	75	88	1
	3-88	(A)	50	22	20	7		1	96	50	72	85	1
	3-118*							29	95	39	73	87	1
	4-127	(C)	6	12	70	11		1	98	70	75	90	3
	4-128	(C)	26	4	67	3		0	98	67	78	92	2
	4-129	(A)	49	19	28	4		1	98	49	76	88	1
	5-162	(B)	13	49	17	9	11	1	100	49	72	87	1
	5-166	(A)	86	2	4	2	5	1	99	86	78	91	4
	5-167	(B)	16	73	4	6	0	0	99	73	80	95	3
Application	3-87	(D)	4	38	8	49		1	96	49	73	88	1

*Number of students for question 3-118 is 956.

9. A shaded figure and an unshaded figure are shown below.



The ratio of the area of the shaded figure to the area of the unshaded figure is:

A) 1:4
B) 1:2
C) 4:1
D) 2:1

11. Which ratio is equivalent to 3:4?

A) 9:12
B) 8:6
C) 1:3
D) 8:9

89. The ratio 6:5 written in fractional form is:

A) $\frac{1}{6}$

B) $\frac{1}{5}$

C) $\frac{5}{6}$

D) $\frac{6}{5}$

130. The ratio 16:12 in lowest terms is:

A) 4:3
B) 6:8
C) 8:6
D) 3:4

10. In a school of 800 pupils, 300 are boys. The ratio of the number of boys to the number of girls is.

A) 3:8
B) 8:3
C) 5:3
D) 3:5

49. The scale on a floor plan is 1:50. What length does 3 cm on the floor plan represent?

A) 150 cm
B) 100 cm
C) 30 cm
D) 16.6 cm

50. Penelope sorted coins into piles of nickels, dimes, and quarters. Each pile had the same value. A ratio to compare the number of nickels, dimes, and quarters is:

A) 2:5:10
B) 2:10:5
C) 5:10:2
D) 10:5:2

51. A car travels at an average speed of 90 km/h. How long will it take to travel 225 km?

A) 2 h
B) 2.5 h
C) 3 h
D) 3.5 h

90. During a basketball game, Ahmed succeeded on 4 out of 7 of his shots and Jim sank 5 out of 9 of his shots. During this game, who was the more accurate?

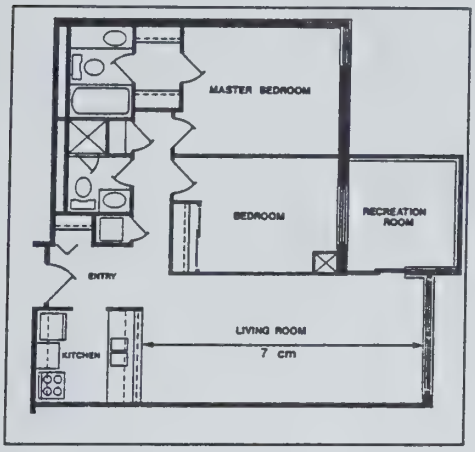
A) Ahmed
B) Jim
C) neither
D) not enough information given

91. For the annual school play, the ratio of adult tickets sold to student tickets sold was 5:3. If 90 adult tickets were sold, what was the total number of tickets sold?

A) 54
B) 105
C) 144
D) 150

Ratio and Rate (cont'd)

131. In the apartment pictured below, the actual length of the living room is 7 m (700 cm). The length of the living room on the plan is 7 cm.



What is the scale used to draw the diagram?

A) 1:7
B) 1:10
C) 1:100
D) 1:700

132. For every 3 hamburgers sold in a restaurant, 2 hot dogs are sold. If 36 hamburgers were sold, how many hot dogs were sold?

A) 12
B) 18
C) 24
D) 54

170. A painter is to mix green and yellow paint in the ratio of 4 to 7 to obtain the colour he wants. If he has 28 L of green paint, how many litres of yellow paint should be added?

A) 196 L
B) 49 L
C) 28 L
D) 16 L
E) 11 L

Table D-4
Numerical Methods and Algebra: Ratio and Rate

											Panel Rating		
Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Acc*	*Des*	*Rtg*
Comprehension	1-9	(B)	17	66	3	13		1	94	66	73	85	2
	1-11	(A)	89	5	3	2		1	93	89	77	88	4
	3-89	(D)	1	1	15	82		0	93	82	79	92	3
	4-130	(A)	84	1	11	4		0	93	84	76	91	4
Application	1-10	(D)	13	12	9	66		0	93	66	70	83	2
	2-49	(A)	62	4	24	7		2	86	62	73	85	3
	2-50	(D)	12	7	21	58		1	89	58	60	75	3
	2-51	(B)	6	80	8	6		0	97	80	72	85	4
	3-90	(A)	72	13	8	7		0	95	72	67	80	4
	3-91	(C)	22	14	42	20		2	92	42	65	80	2
	4-131	(C)	15	6	54	24		1	72	54	73	88	2
	4-132	(C)	9	14	73	2		0	95	73	73	85	3
	5-170	(B)	8	62	9	15	5	1	92	62	72	83	3

12. The fraction equivalent to 5% is:

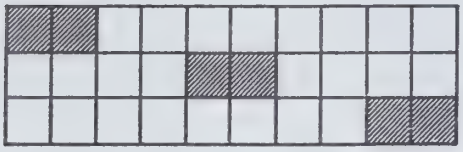
A) $\frac{1}{5}$

B) $\frac{1}{20}$

C) $\frac{5}{10}$

D) $\frac{5}{1}$

53. Some squares in the 3 × 10 grid below are shaded.



What per cent of the 3 × 10 grid is shaded?

A) 20%
B) 6%
C) 3%
D) $\frac{1}{5}$%

54. Expressed as a per cent, $\frac{3}{8}$ is:

A) 0.375%
B) 3.75%
C) 37.5%
D) 375.0%

92. Expressed as a decimal 123% is:

A) 0.123
B) 1.23
C) 12.3
D) 123.0

133. Express 7% as a decimal.

A) 0.07
B) 0.7
C) 7.0
D) 70.0

134. What per cent is 0.005?

A) 0.005%
B) 0.05%
C) 0.5%
D) 5.0%

163. The fraction $\frac{1}{5}$ is equal to:

A) 0.20%
B) 2%
C) 5%
D) 20%
E) 25%

165. 20% of 125 is equal to:

A) 6.25
B) 12.50
C) 15
D) 25
E) 50

13. Nunzio received a mark of 20 out of 80 on a science test. What per cent did he receive on the test?

A) 40%
B) 25%
C) 20%
D) 4%

14. What is the interest for 1 year on a loan of $800 at 13% per year?

A) $104
B) $800
C) $904
D) $1 704

15. A tape cassette costs $8.29. At 8%, what is the sales tax to the nearest cent?

A) 67¢
B) 66¢
C) 65¢
D) 63¢

52. Rich sold a computer system for $2 500. He received a commission of 6%. His commission was:

A) $150
B) $1 500
C) $2 350
D) $2 650

Per Cent (cont'd)

93. Nunzio received a mark of 29 out of 50 on a science test. What per cent did he receive on the test?

A) 58%
B) 50%
C) 29%
D) $14\frac{1}{2}\%$

94. The regular price of a shirt is $55. It is on sale at a discount of 30%. If the sales tax is 8%, how much money would you need to buy the shirt?

A) $16.50
B) $20.90
C) $38.50
D) $41.58

135. Julie received a discount of $40 on a skateboard. She paid $60 for the skateboard. What was the percentage discount?

A) 30%
B) 40%
C) 60%
D) 67%

169. Candidate A received 70 per cent of the votes cast in an election. If 4 200 votes were cast in the election, how many votes did Candidate A receive?

A) 2 800
B) 2 900
C) 2 940
D) 3 000
E) 4 130

Table D-5
Numerical Methods and Algebra: Per Cent

										Panel Rating		
Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Acc*	*Des*	*Rtg*
Comprehension	1-12	(B)	16	51	22	10		0	97	51	75	85	1
	2-53	(A)	43	31	12	13		1	95	43	72	85	1
	2-54	(C)	42	18	36	2		2	96	36	75	88	1
	3-92	(B)	27	54	5	14		0	95	54	72	90	2
	4-133	(A)	70	22	7	1		0	97	70	78	90	3
	4-134	(C)	32	14	46	8		0	93	46	65	80	1
	5-163	(D)	18	6	14	59	3	1	98	59	77	89	1
	5-165	(D)	17	9	13	57	2	1	95	57	74	88	2
Application	1-13	(B)	26	57	12	5		0	97	57	75	85	1
	1-14	(A)	79	3	12	5		1	90	79	70	83	3
	1-15	(B)	11	61	15	12		2	92	61	70	85	2
	2-52	(A)	73	15	5	4		2	92	73	75	90	3
	3-93	(A)	90	2	5	3		0	98	90	80	95	4
	3-94	(D)	9	17	33	39		2	92	39	65	80	2
	4-135	(B)	12	61	15	12		1	90	61	72	84	2
	5-169	(C)	7	8	54	19	10	2	94	54	73	88	2

Integers

16. Which integer is represented by point A on the number line?

A) +3
B) +2
C) −2
D) −4

17. Calculate (+20) + (−5).

A) −15
B) −7
C) +15
D) +25

18. Calculate (−8) − (−7).

A) +15
B) +1
C) −1
D) −15

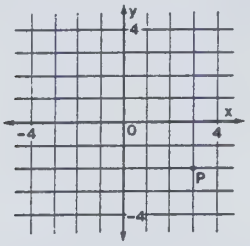
55. Which of these integers is greater than −3?

A) 0
B) −4
C) −6
D) −10

56. Calculate (−2) − (+5).

A) −7
B) −3
C) +3
D) +7

57. Point P is marked on the grid below.



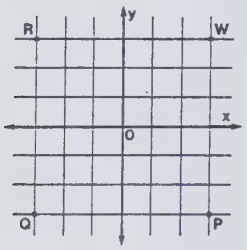
What are the coordinates of point P?

A) (3, −2)
B) (−2, 3)
C) (−3, 2)
D) (2, −3)

95. Which of the following represents integers listed in order from least to greatest?

A) −6, −4, +2, +6
B) +2, +6, −4, −6
C) +2, +6, −6, −4
D) −6, +6, −4, +2

96. Four points are labelled on the following grid.



Which point is represented by the coordinates (−3, +3)?

A) W
B) P
C) R
D) Q

Integers (cont'd)

97. $(+8) - (-2)$ is equivalent to:

A) $(-8) + (-2)$
B) $(+8) + (+2)$
C) $(-8) + (+2)$
D) $(+8) + (-2)$

136. Calculate $(-13) + (-80)$.

A) +93
B) +67
C) −67
D) −93

138. On the following number line, which letter represents the integer +3?

A) W
B) X
C) Y
D) Z

191. Point P is shown below.

What are the coordinates of point P?

A) (4, −3)
B) (−4, −3)
C) (3, 4)
D) (−3, 4)
E) (−4, 3)

137. On December 15, the temperature inside a science lab was 21°C. The temperature outside was −6°C. How many degrees warmer was it inside the lab than outside?

A) −27
B) −15
C) 15
D) 27

193. The air temperature at the foot of a mountain is 31°C. On top of the mountain the temperature is −7°C. How much warmer is the air at the foot of the mountain.

A) −38°
B) −24°
C) 7°
D) 24°
E) 38°

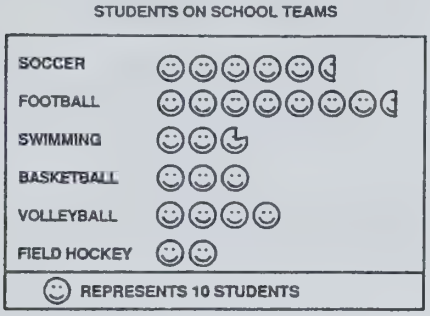
194. On a number line, two points A and B are given. The coordinate of A is −3 and the coordinate of B is +7. What is the coordinate of the point C, if B is the midpoint of the line segment AC?

A) −13
B) $-\frac{1}{2}$
C) +2
D) +12
E) +17

Table D-6
Numerical Methods and Algebra: Integers

Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Panel Rating*		
											Acc	*Des*	*Rtg*
Comprehension	1-16	(C)	1	5	91	3		0	77	9i	85	95	3
	1-17	(C)	11	1	75	13		0	77	75	77	87	3
	1-18	(C)	11	8	55	27		0	76	55	74	82	2
	2-55	(A)	94	2	1	1		1	77	94	77	90	5
	2-56	(A)	39	9	42	9		1	74	39	72	87	1
	2-57	(A)	48	28	12	8		2	56	48	70	85	1
	3-95	(A)	88	5	3	3		1	77	88	78	90	4
	3-96	(C)	12	24	47	13		4	55	47	75	87	1
	3-97	(B)	8	44	22	25		1	74	44	70	85	2
	4-136	(D)	18	7	11	64		1	78	64	78	90	2
	4-138	(D)	6	1	3	91		0	78	91	86	96	4
	5-191	(A)	54	6	6	29	4	1	55	54	75	86	2
Application	4-137	(D)	4	7	31	56		1	81	56	70	88	2
	5-193	(E)	7	7	4	32	49	1	82	49	73	86	1
	5-194	(E)	8	8	30	17	34	3	59	34	68	81	2

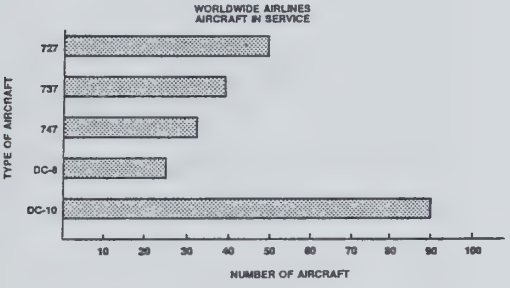
19. The diagram below shows the number of students on some school teams.



What was the total number of students on the football and soccer teams?

A) 130
B) 120
C) 13
D) 12

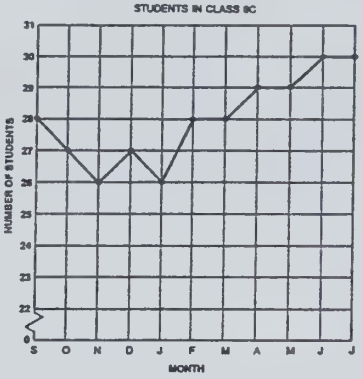
20. The graph below shows the number of aircraft for Worldwide Airlines.



The total number of aircraft Worldwide Airlines has in service is about:

A) 235
B) 250
C) 265
D) 280

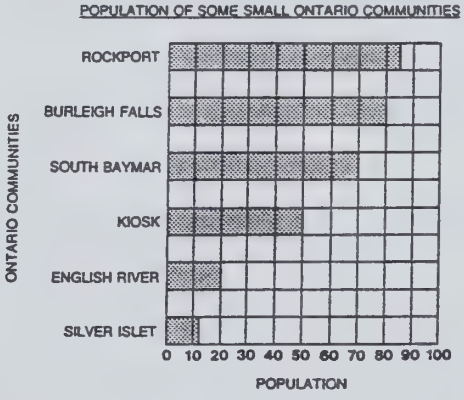
21. The line graph below shows the enrolments in class 8C at the beginning of each month of 1987-88.



During which month did the number of students increase the most?

A) January
B) September
C) June
D) May

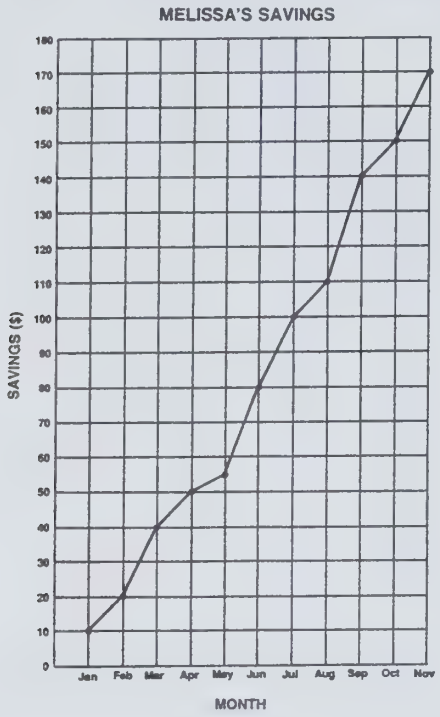
58. There are many small communities in Ontario with populations less than 100 persons. The bar graph below shows six of these communities.



How many more people live in Rockport than in Kiosk?

A) 20
B) 25
C) 30
D) 35

59. Melissa started a savings plan in order to save $160 to purchase a new bicycle. The graph below shows her progress.



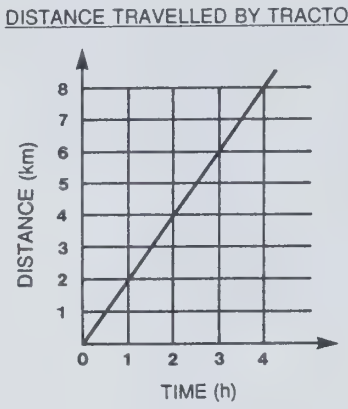
At the end of which month did Melissa have exactly one half the amount of money needed for her bicycle?

A) September
B) May
C) June
D) July

60. For which of the following situations would a circle graph be the most suitable form of illustration?

A) the speeds at which you ran your last 6 races
B) the way you spent your time during the last 24 h
C) your increase in height from birth to the present
D) the temperature over a 5-day period

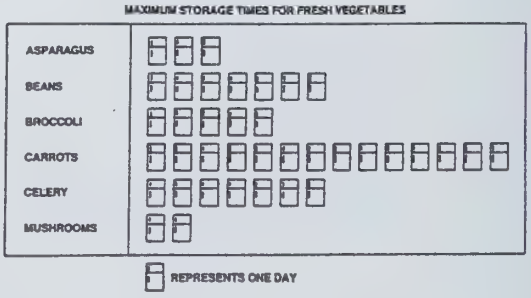
98. The graph below shows the distance travelled by a tractor during a period of 4 h.



How far does the tractor move in one hour?

A) 1 km
B) 2 km
C) 4 km
D) 8 km

99. The diagram below shows the number of days that different vegetables can be stored.

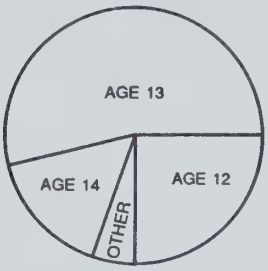


According to the diagram, which vegetables can be stored for one week or longer?

A) carrots, celery, and mushrooms
B) celery, carrots, and broccoli
C) beans, carrots, and celery
D) beans, carrots, and broccoli

100. The circle graph below shows the ages of students in Grade 8.

GRADE 8 STUDENT AGES
OAK ROAD SCHOOL



According to the above graph, which statement is definitely true about Grade 8 students in Oak Road School?

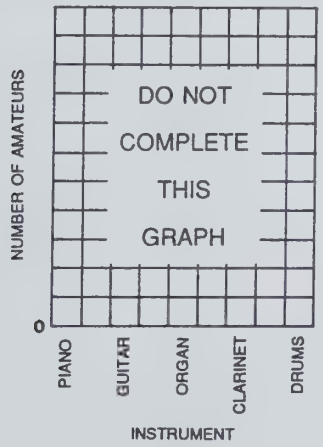
A) There are absolutely no 15-year-olds.
B) There are definitely some 10-year-olds.
C) There are more 12-year-olds than 14-year-olds.
D) There are more 14-year-olds than 13-year-olds.

139. A list of the five most popular musical instruments played by amateurs is given below.

INSTRUMENT	NUMBER OF AMATEURS
PIANO	18 000 000
GUITAR	15 000 000
ORGAN	6 000 000
CLARINET	3 000 000
DRUMS	2 000 000

This data could be plotted on the grid below to make a bar graph.

NUMBER OF AMATEURS PLAYING INSTRUMENTS

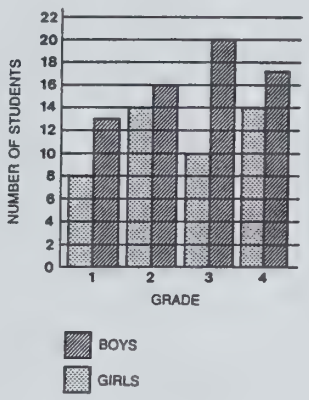


What is an appropriate scale for the above graph?

A) 1 unit represents 1 000 000 amateurs
B) 1 unit represents 10 000 000 amateurs
C) 1 unit represents 2 000 000 amateurs
D) 1 unit represents 500 000 amateurs

140. The graph below shows the number of boys and girls in each grade.

STUDENTS IN GRADES 1, 2, 3, AND 4



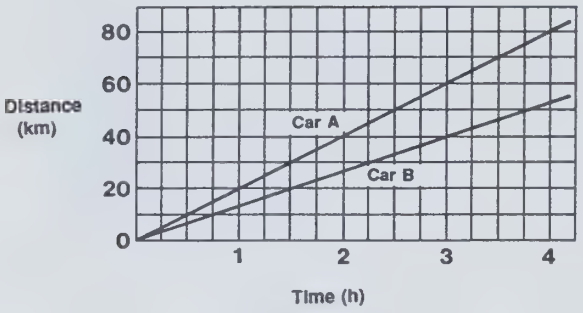
Which of these is a TRUE statement about the information shown on the graph?

A) Grade 2 has the fewest number of students.
B) Grade 2 and 4 have the same number of students.
C) Grade 4 has more girls than boys.
D) Grade 3 has twice as many boys as girls.

141. Asim receives an allowance of $12 a week. He saves $4 of it for clothing. To represent this savings on a circle graph, the number of degrees needed would be:

A) 240
B) 120
C) 90
D) 30

190. Look at the graph below.



Three hours after starting, Car A is how many kilometres ahead of Car B?

A) 2
B) 10
C) 15
D) 20
E) 25

195. The circle graph shows the proportion of various grain crops produced by a country.

Which of the following is TRUE?

A) More oats than rye is produced.
B) The largest crop is barley.
C) Equal quantities of wheat and barley are produced.
D) The smallest crop is oats.
E) Wheat and oats together make up less than half the total grain crop.

Table D-7
Numerical Methods and Algebra: Organization and Representation of Data

										Panel Rating		
Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Acc*	*Des*	*Rtg*
Application	1-19	(A)	84	2	13	1		0	88	84	80	90	3
	1-20	(A)	78	13	4	5		1	90	78	75	87	3
	1-21	(A)	61	1	36	2		0	89	61	75	92	2
	2-58	(D)	1	5	3	91		0	87	91	78	90	5
	2-59	(C)	5	12	79	4		1	84	79	75	90	4
	2-60	(B)	12	66	8	14		1	67	66	68	80	3
	3-98	(B)	8	81	3	7		0	81	81	80	92	3
	3-99	(C)	1	1	96	1		0	85	96	80	95	5
	3-100	(C)	4	2	92	2		0	79	92	75	88	5
	4-139	(C)	27	9	54	9		1	74	54	74	86	3
	4-140	(D)	1	3	2	93		0	85	93	80	92	5
	4-141	(B)	10	44	23	20		3	67	44	68	82	2
	5-190	(D)	13	8	6	58	14	1	75	58	76	87	2
	5-195	(A)	91	2	3	2	3	1	78	91	81	92	4

Variables, Formulas, and Equations

22. What is the value of the expression $5x - 9y$ when $x = 7$ and $y = 3$?

A) −52
B) 8
C) 26
D) 62

24. A number is doubled and the result is decreased by 5. An expression for this information is:

A) $5 - 2n$
B) $n - 2 - 5$
C) $2n - 5$
D) $n - 2 \times 5$

61. If $n = 2$, then $19 - 2n$ equals:

A) −3
B) 15
C) 19
D) 23

62. Sixteen added to the product of three and a number is 31. An equation for this statement is:

A) $3m - 16 = 31$
B) $3m \times 16 = 31$
C) $3m + 16 = 31$
D) $3(16) + m = 31$

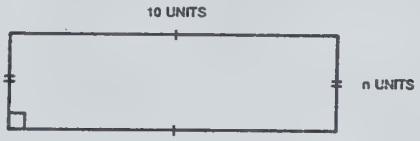
63. In the equation $50 = 7y + 1$, what is the value of y?

A) 9
B) 8
C) 7
D) 6

101. What is the value of the expression $5(b + 3)$ when $b = 7$?

A) 50
B) 38
C) 35
D) 15

103. Examine the following rectangle.



The equation $2(n + 10) = 24$ tells that:

A) the area of the rectangle is 24 square units.
B) the length of the rectangle is 10 times its width.
C) twice the length of the rectangle is 24 units.
D) the perimeter of the rectangle is 24 units.

142. What is the value of $a^2 + b^3$ if $a = 3$ and $b = 2$?

A) 12
B) 13
C) 15
D) 17

144. What is the value of p in $\frac{p}{2} + 5 = 9$?

A) 4
B) 7
C) 8
D) 14

171. When $x = 2$, $\frac{7x + 4}{5x - 4}$ is equal to:

A) 11
B) 3
C) $\frac{11}{5}$
D) $\frac{9}{5}$
E) $\frac{7}{5}$

173. $A = XY$. If $A = 12$ and $X = 3$, then Y is equal to:

A) $\frac{3}{4}$
B) 3
C) 4
D) 12
E) 36

Variables, Formulas, and Equations (cont'd)

23. The price of tennis balls is as follows:

1 tennis ball	$ 3.50
2 tennis balls	$ 7.00
3 tennis balls	$10.50

If n represents the number of tennis balls, which formula can be used to find the cost of any number of tennis balls?

A) 3.50n
B) 3.50 + 3n
C) 3.50 + 2n
D) 3.50 + n

102. A cycle factory makes bicycles and tricycles. Each day b bicycles and t tricycles are produced. The expression which shows the total number of bicycle and tricycle tires required each day is:

A) 2 + b + 3 + t
B) 2t + 3b
C) 2b + 3t
D) 2 + t + 3 + b

143. A worker earns $400 per week plus $15 for each hour of overtime. If she worked n hours of overtime, which expression represents her weekly wages?

A) 400 + 15n
B) 400 + n
C) 400n + 15
D) 400 + 15 + n

172. A number x is multiplied by itself and the result is added to four times the original number. This can be expressed as:

A) $x^2 = 4$
B) $x + 4$
C) $2x + 4$
D) $x(x^2 + 4)$
E) $x^2 + 4x$

196. The table below compares the height from which a ball is dropped (d) and the height to which it bounces (b).

d	50	80	100	150
b	25	40	50	75

Which formula describes this relationship?

A) $b = d^2$

B) $b = 2d$

C) $b = \frac{d}{2}$

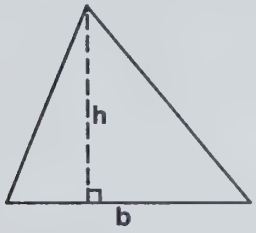
D) $b = d + 25$

E) $b = d - 25$

Table D-8
Numerical Methods and Algebra: Variables, Formulas, and Equations

										Panel Rating		
Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Acc*	*Des*	*Rtg*
Comprehension	1-22	(B)	10	69	10	9		1	77	69	75	85	3
	1-24	(C)	7	8	74	10		1	74	74	70	80	3
	2-61	(B)	11	78	6	3		1	78	78	78	90	3
	2-62	(C)	4	4	68	22		1	74	68	70	85	3
	2-63	(C)	6	11	76	5		2	74	76	75	85	3
	3-101	(A)	70	10	8	11		1	83	70	77	87	3
	3-103	(D)	27	10	9	53		1	82	53	75	88	2
	4-142	(D)	15	8	11	65		1	84	65	70	83	3
	4-144	(C)	33	7	55	3		2	78	55	69	83	2
	5-171	(B)	10	62	10	8	7	2	82	62	71	83	2
	5-173	(C)	6	4	72	5	11	1	76	72	73	86	3
Application	1-23	(A)	59	10	5	25		1	73	59	72	85	2
	3-102	(C)	15	16	60	7		2	70	60	72	83	3
	4-143	(A)	63	21	5	11		0	81	63	70	85	3
	5-172	(E)	16	7	12	12	52	1	77	52	68	80	2
	5-196	(C)	18	22	43	9	6	2	59	43	70	82	2

25. The triangle below has base b and height h.



The expression used to find the area of the triangle is:

A) $\frac{1}{2}b + h$

B) $b + h$

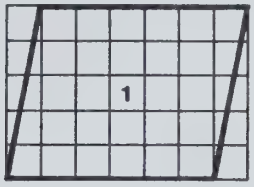
C) $2(b \times h)$

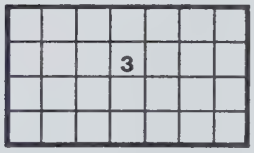
D) $\frac{1}{2}(b \times h)$

28. To convert a measurement from millilitres to litres:

A) multiply the number of millilitres by 100.
B) multiply the number of millilitres by 1 000.
C) divide the number of millilitres by 100.
D) divide the number of millilitres by 1 000.

67. Four figures are drawn below with dark black lines.

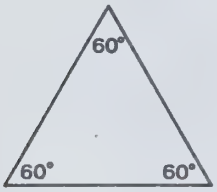




Which two figures above have the same area?

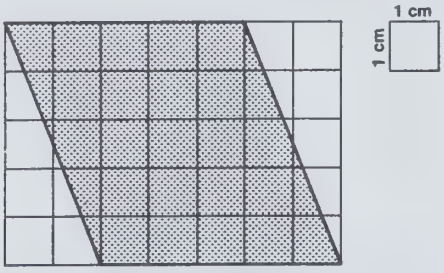
A) 2 and 4
B) 1 and 2
C) 3 and 4
D) 2 and 3

70. This triangle is called:



A) scalene
B) equilateral
C) obtuse
D) right-angled

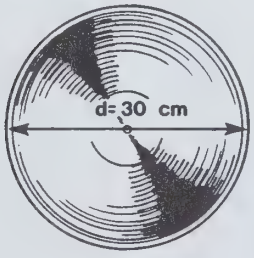
26. Each small square below has an area of 1 cm^2.



What is the area of the shaded parallelogram in the above diagram?

A) 12.5 cm^2
B) 20 cm^2
C) 25 cm^2
D) 30 cm^2

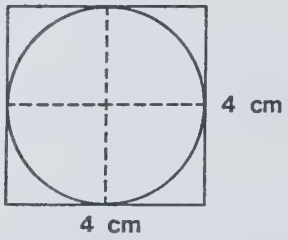
27. A record has a diameter of 30 cm.



$C \div d = \pi$, and π is approximately equal to 3.14. The circumference (C) of this record is closest to:

A) 85 cm
B) 95 cm
C) 105 cm
D) 115 cm

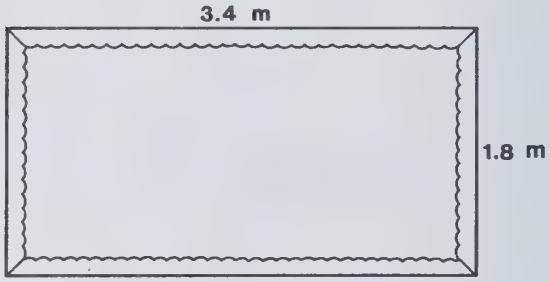
64. The diagram below shows a circle inside a square with sides 4 cm long.



How much larger is the area of the square than the area of the circle? (use $\pi = 3.14$)

A) 28.56 cm^2
B) 16 cm^2
C) 12.56 cm^2
D) 3.44 cm^2

65. Stan and Marcia are decorating a bulletin board in their classroom. It measures 1.8 m by 3.4 m.



The total length of border decoration needed to surround the board is:

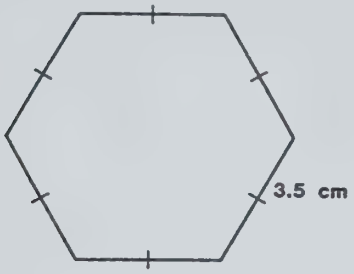
A) 5.2 m
B) 6.12 m
C) 8.6 m
D) 10.4 m

66. The width of a chalkboard is 5 m. This is equivalent to:

A) 500 mm
B) 500 cm
C) 500 dm
D) 500 km

Measurement (cont'd)

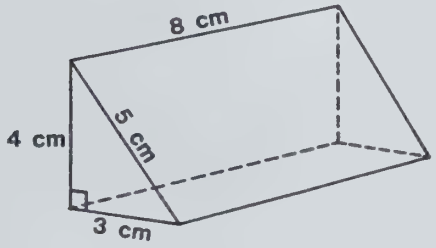
104. The length of each side of the figure below is 3.5 cm.



The perimeter of the figure is:

A) 17.5 cm
B) 21 cm
C) 175 cm
D) 210 cm

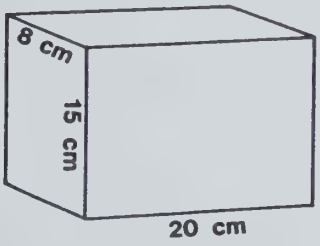
105. The dimensions of a triangular prism are shown in the diagram below.



What is the surface area of this triangular prism?

A) 120 cm^2
B) 108 cm^2
C) 96 cm^2
D) 76 cm^2

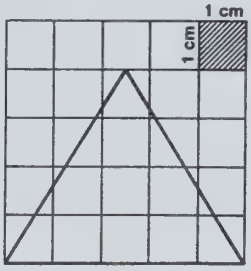
106. The dimensions of the box below are 8 cm × 15 cm × 20 cm.



What is the volume of the above box?

A) 43 cm^3
B) 300 cm^3
C) 1 160 cm^3
D) 2 400 cm^3

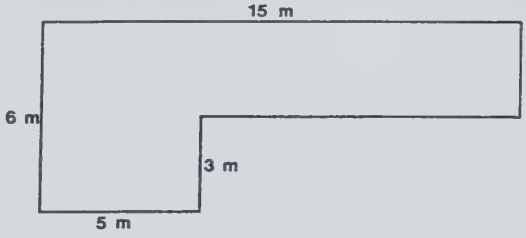
107. Each small square in the diagram below has an area of 1 cm^2.



What is the area of the triangle shown above?

A) 7 cm^2
B) 10 cm^2
C) 15 cm^2
D) 20 cm^2

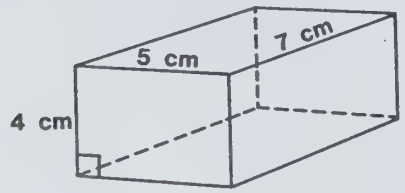
145. Here is the plan of a garden.



The area of the garden in square metres is:

A) 90
B) 60
C) 45
D) 30

146. The dimensions of the box shown below are 4 cm × 5 cm × 7 cm.



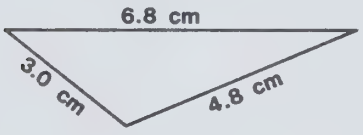
If there is no overlap, what is the least amount of paper needed to cover this box?

A) 180 cm^2
B) 166 cm^2
C) 152 cm^2
D) 140 cm^2

147. What is the volume of a hexagonal-shaped pencil which has an end (base) with an area of 48 mm^2 and a length of 200 mm?

A) 148 mm^3
B) 248 mm^3
C) 496 mm^3
D) 9 600 mm^3

148. The dimensions of a triangle are given below.



What is the perimeter of this triangle?

A) 14.6 cm
B) 7.8 cm
C) 7.3 cm
D) 13 cm

174. A 15-cm piece is cut from a ribbon one metre long. What is the length of the remaining piece?

A) 85 cm
B) 115 cm
C) 985 cm
D) 1 015 cm
E) 9 985 cm

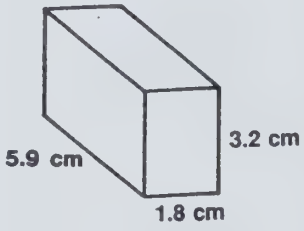
175. When using the metric system, the distance between two towns is usually measured in:

A) millimetres
B) centimetres
C) decimetres
D) metres
E) kilometres

176. A solid plastic cube one centimetre long has a mass of one gram. What will be the mass of a solid cube of the same plastic if each edge is 2 cm long?

A) 8 g
B) 4 g
C) 3 g
D) 2 g
E) 1 g

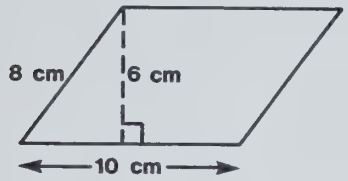
177. The figure below shows a rectangular box.



Which of the following is closest to the volume of this box.

A) 48 cm^3
B) 36 cm^3
C) 28 cm^3
D) 18 cm^3
E) 16 cm^3

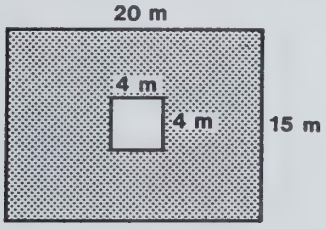
178. The figure below is a parallelogram.



What is the area of the above parallelogram?

A) 80 cm^2
B) 60 cm^2
C) 48 cm^2
D) 36 cm^2
E) 30 cm^2

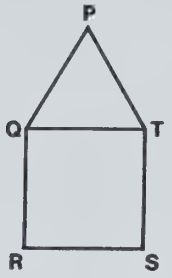
179. A square is removed from the rectangle as shown below.



What is the area of the remaining part?

A) 316 m^2
B) 300 m^2
C) 284 m^2
D) 80 m^2
E) 16 m^2

180. The figure QRST is a square and PQT is an equilateral triangle.



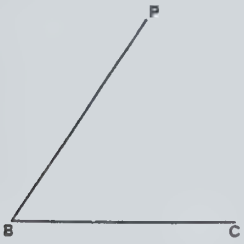
If PQ = 6 cm, then the area of the square is:

A) 64 cm^2
B) 48 cm^2
C) 40 cm^2
D) 36 cm^2
E) 24 cm^2

Table D-9
Measurement and Geometry: Measurement

											Panel Rating		
Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Acc*	*Des*	*Rtg*
Comprehension	1-25	(D)	10	15	21	53		0	86	53	70	83	1
	1-28	(D)	32	40	12	14		2	93	14	75	88	1
	2-67	(D)	14	12	11	61		1	87	61	74	90	2
	2-70	(B)	7	83	5	4		1	86	83	84	95	3
Application	1-26	(C)	3	7	83	6		1	88	83	72	87	4
	1-27	(B)	10	72	10	7		2	84	72	65	80	3
	2-64	(D)	7	19	28	43		3	78	43	64	80	2
	2-65	(D)	13	28	4	54		1	95	54	80	90	2
	2-66	(B)	10	80	7	2		1	97	80	80	95	3
	3-104	(B)	9	76	3	12		0	93	76	82	93	3
	3-105	(B)	31	22	30	14		3	58	22	60	75	1
	3-106	(D)	8	11	11	68		1	79	68	75	91	3
	3-107	(B)	18	65	10	7		1	87	65	72	85	3
	4-145	(B)	11	46	22	19		2	89	46	71	85	2
	4-146	(B)	7	22	7	64		1	73	22	66	80	1
	4-147	(D)	5	27	15	51		2	50	51	67	82	2
	4-148	(A)	94	2	2	2		1	93	94	84	95	4
	5-174	(A)	85	5	6	2	2	0	98	85	79	93	4
	5-175	(E)	2	1	1	4	92	1	96	92	90	98	4
	5-176	(A)	16	16	5	61	1	1	65	16	70	83	1
	5-177	(B)	11	48	12	12	15	2	76	48	73	85	2
	5-178	(B)	13	54	16	9	7	1	83	54	74	86	2
	5-179	(C)	4	9	63	10	13	1	85	63	71	83	3
	5-180	(D)	5	5	4	59	27	1	83	59	72	84	2

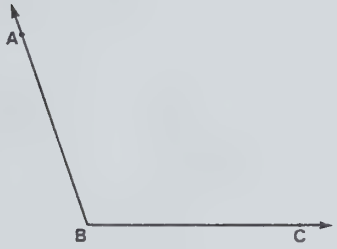
29. Complete the construction of △ ABC below, making ∠ BCA = 43°. Point A must be on BP.



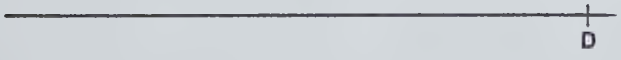
The length of AC in millimetres is between:

A) 47 and 54
B) 55 and 62
C) 63 and 70
D) 71 and 78

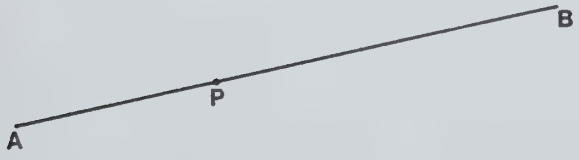
36. Bisect ∠ ABC.



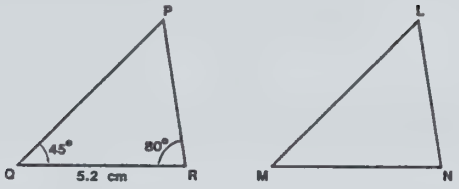
37. On the given line, construct a line segment CD congruent to line segment AB.



38. Construct a line through P perpendicular to AB.



69. △ LMN is congruent to △ PQR.



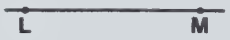
Which statement is true?

A) LM = 5.2 cm
B) ∠ LMN = 65°
C) LN = 5.2 cm
D) ∠ MLN = 55°

72. Which line segment is congruent to line segment PQ?

A)

B)

C) 

D)

74. Complete the construction of △ ABC below, making AB = 5 cm and AC = 7 cm.

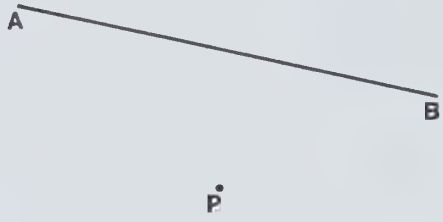
The measure of ∠BAC is between:

A) 112° and 118°
B) 105° and 111°
C) 98° and 104°
D) 91° and 97°

Constructions (cont'd)

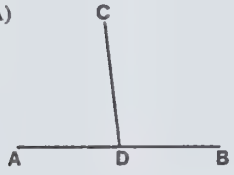
76. Complete the construction of parallelogram ABCD.

77. Construct a line through P perpendicular to AB.

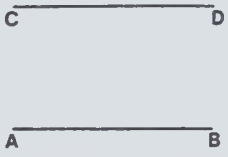


108. Which of the following figures shows CD perpendicular to AB?

A)

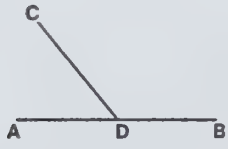


B)

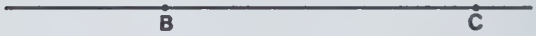


C)

D)



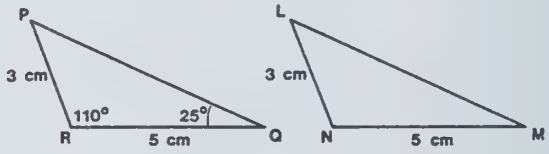
109. Complete the construction of $\triangle$ ABC on the line segment below so that $\angle$ ABC = 90° and AB = 5 cm.



The length of AC in centimetres is between:

A) 7.1 and 7.7
B) 7.8 and 8.4
C) 8.5 and 9.1
D) 9.2 and 9.8

110. $\triangle$ LMN is congruent to $\triangle$ PQR.

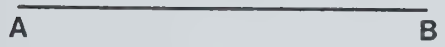


$\angle$LNM must be equal to:

A) 25°
B) $\angle$ PQR
C) $\angle$ PRQ
D) 45°

Constructions (cont'd)

156. Construct the perpendicular bisector of line segment AB.



157. Complete the construction of △ ABC below, making AC = 6 cm.
Point A must be between points B and F.

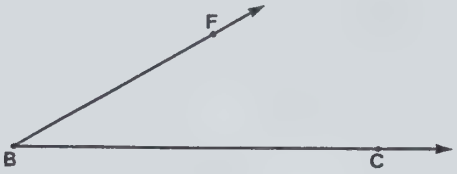


Table D-10
Measurement and Geometry: Construction

Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Panel Rating* *Acc*	*Des*	*Rtg*
Comprehension	1-29	(C)	14	19	42	21		4	69	42	70	82	1
	1-36*							21	68	59	70	85	2
	1-37*							16	71	54	80	90	1
	1-38*							20	69	45	72	82	1
	2-69	(D)	9	22	12	53		3	75	53	70	85	2
	2-72	(D)	2	3	12	81		1	78	81	80	95	3
	2-74	(A)	39	23	21	13		5	66	39	68	80	2
	2-76*							15	55	51	70	85	2
	2-77*							15	66	43	70	85	1
	3-108	(C)	4	25	65	5		1	82	65	80	95	3
	3-109	(D)	15	14	16	51		4	69	51	70	87	2
	3-110	(C)	17	24	50	6		1	76	50	78	90	2
	4-156*							22	65	55	73	88	2
	4-157*							19	63	48	75	88	2

*Number of students for open-ended questions is 964, 964, 958, 954, 954, 952, and 951 (order as in table).

182. Which one of the indicated angles is ACUTE?

A)

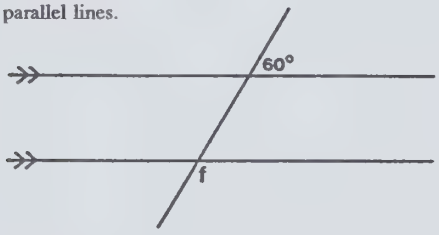
B)

C)

D)

E)

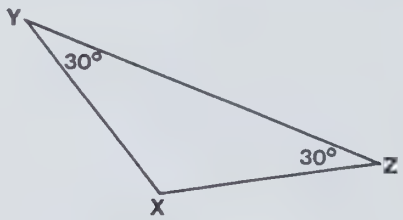
30. The diagram below shows a straight line intersecting two parallel lines.



What is the measure of angle f?

A) 30°
B) 60°
C) 120°
D) 180°

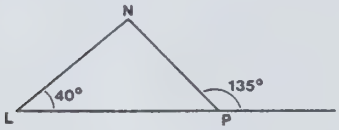
31. In the triangle below, the measures for $\angle Y$ and $\angle Z$ are given.



What is the measure of $\angle X$?

A) 30°
B) 60°
C) 90°
D) 120°

68. The diagram below shows a triangle and an external angle.

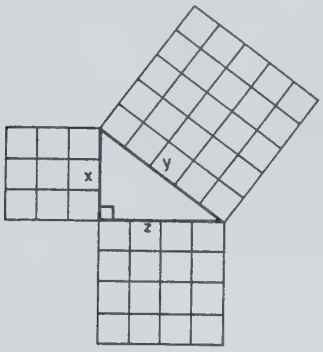


What is the measure of $\angle LNP$?

A) 45°
B) 70°
C) 95°
D) 175°

Properties of Plane Figures (cont'd)

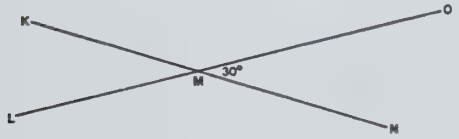
71. In the triangle below, the lengths of the sides are represented by x, y, and z.



Which of the following statements is true?

A) $z^2 = x^2 + y^2$
B) $x^2 = y^2 + z^2$
C) $y^2 = x^2 + z^2$
D) $x = y + z$

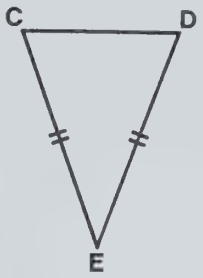
111. The diagram below shows the intersection of two straight line segments.



What is the measure of $\angle$ KML?

A) 30°
B) 80°
C) 150°
D) 180°

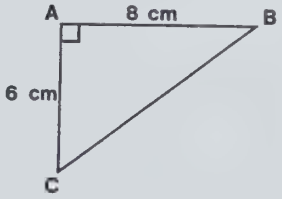
112. $\triangle$ CDE is an isosceles triangle.



Which angles have the same measure?

A) $\angle$ C and $\angle$ E
B) $\angle$ D and $\angle$ E
C) $\angle$ C and $\angle$ D
D) $\angle$ C, $\angle$ D, and $\angle$ E

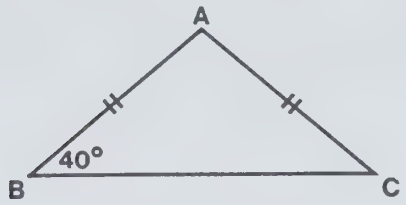
113. The lengths of two sides are given for the triangle below.



The length of BC is:

A) 7 cm
B) 10 cm
C) 14 cm
D) 100 cm

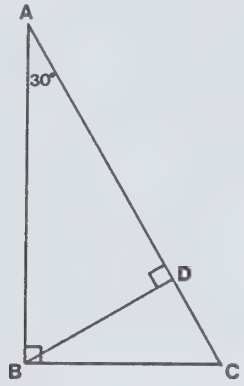
149. Triangle ABC is an isosceles triangle. The measure of ∠ B is given.



What is the measure of ∠ A?

A) 60°
B) 90°
C) 100°
D) 140°

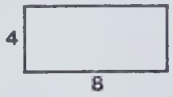
150. The measure of ∠ A is given in the diagram below.



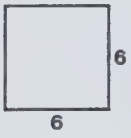
What is the measure of angle ∠ DBC?

A) 30°
B) 45°
C) 60°
D) 90°

185. Look at the following figure.

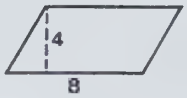


One of the following figures is congruent to the figure above. Which one?

A)


B)

C)

D)


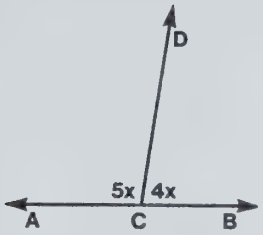
E)

186. All parallelograms must have:

A) one pair of adjacent sides equal.
B) one pair of parallel sides.
C) a diagonal as axis of symmetry.
D) two adjacent angles equal.
E) two pairs of parallel sides.

Properties of Plane Figures (cont'd)

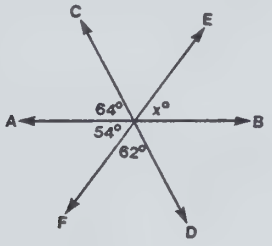
181. AB is a straight line.



What is the measure in degrees of angle BCD?

A) 20
B) 40
C) 50
D) 80
E) 100

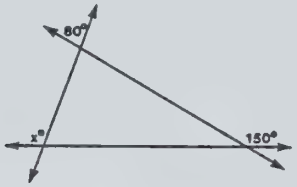
183. AB, CD, and EF are intersecting straight lines as shown below. The measures of certain angles are shown.



x° is equal to:

A) 54
B) 62
C) 64
D) 126
E) 128

184. Three straight lines intersect as shown in the diagram.



x° is equal to:

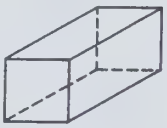
A) 30
B) 50
C) 60
D) 110
E) 150

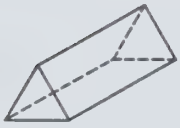
Table D-11
Measurement and Geometry: Properties of Plane Figures

											Panel Rating		
Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Acc*	*Des*	*Rtg*
Recognition/Recall	5-182	(A)	80	5	7	5	1	1	87	80	83	94	3
Comprehension	1-30	(C)	3	46	48	2		1	71	48	73	85	1
	1-31	(D)	8	18	6	68		0	82	68	78	90	2
	2-68	(C)	20	6	51	22		1	78	51	73	85	2
	2-71	(C)	12	12	56	16		3	52	56	70	80	2
	3-111	(A)	76	6	13	4		1	77	76	80	92	3
	3-112	(C)	8	7	75	8		1	82	75	79	92	3
	3-113	(B)	18	57	18	5		1	62	57	70	85	3
	4-149	(C)	9	11	70	10		1	81	70	74	89	3
	4-150	(A)	52	10	18	19		1	75	52	69	84	3
	5-185	(E)	2	2	10	8	77	1	77	77	81	91	3
	5-186	(E)	5	31	7	6	51	1	81	51	76	89	3
Application	5-181	(D)	8	3	3	77	8	1	69	77	69	83	4
	5-183	(A)	75	4	13	4	3	0	77	75	77	89	3
	5-184	(D)	7	6	14	62	9	1	73	62	63	81	3

73. Which drawing represents a hexagonal prism?

A)

B) 

C) 

D)

32. Which of the following figures is not a drawing of a prism?

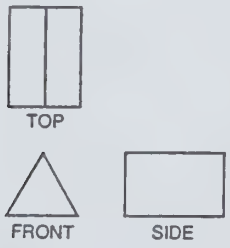
A)

B)

C)

D)

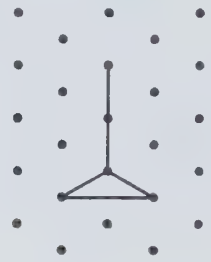
33. The front, top, and side views of a three-dimensional object are given below.



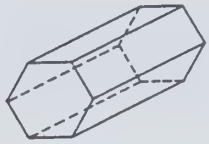
What type of object could be represented by these views?

A) tetrahedron
B) triangular pyramid
C) triangular prism
D) trapezoid

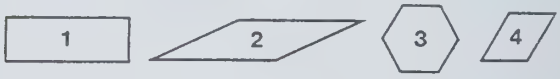
78. Complete the diagram below to show a triangular prism.



114. Study the prism below.

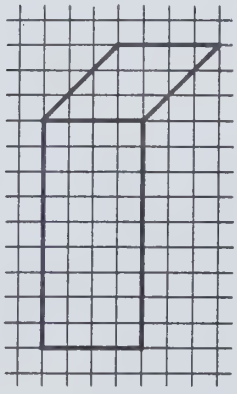


Which figures below can be drawn by tracing the faces of the prism?

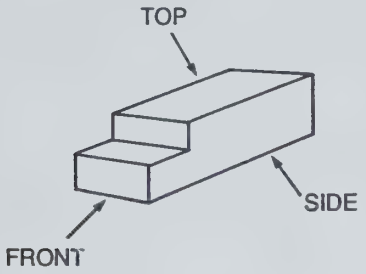


A) only 2 and 3
B) only 2 and 4
C) only 1 and 4
D) only 1 and 3

117. Complete the drawing of the rectangular prism below.



151. The diagram below shows an object with the top, front, and side labelled.



Which of the following views of the above object is the front view?

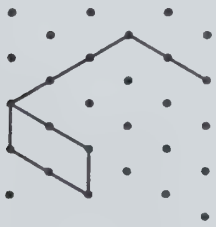
A)

B)

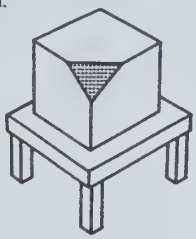
C)

D)

158. Complete the drawing of the rectangular prism below.



188. This figure below shows a wooden cube with one corner cut off and shaded.

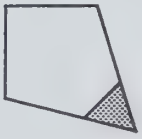


Which of the following drawings shows how this cube would look when viewed from directly above it?

A)

B)

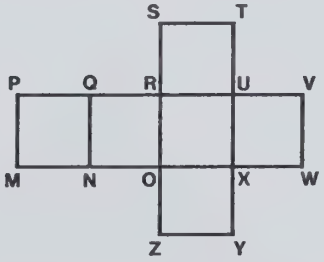
C)



D)

E)

197. The diagram shows a cardboard cube which has been cut along some edges and folded out flat.



If it is folded again to make the cube, which two corners will touch corner P?

A) corners T and V
B) corners T and Y
C) corners W and Y
D) corners Q and S
E) corners U and Y

Table D-12
Measurement and Geometry: Three-Dimensional Geometry

											Panel Rating	
Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Acc*	*Des*	*Rtg*
Recognition/Recall	2-73	(A)	89	4	5	1		1	51	89	77	90	5
Comprehension	1-32	(D)	16	21	22	38		2	50	38	68	85	1
	1-33	(C)	11	17	58	13		1	42	58	60	75	3
	2-78*							14	42	53	70	85	2
	3-114	(D)	7	3	5	84		1	44	84	70	83	5
	3-117*							13	51	71	73	85	3
	4-151	(B)	15	79	4	2		0	48	79	73	85	4
	4-158*							9	51	89	79	92	4
Application	5-188	(E)	2	3	7	16	70	1	38	70	73	86	4
	5-197	(A)	69	13	8	5	5	1	51	69	68	81	3

*Number of students for open-ended questions is 955, 957, and 950 (order as in table).

Transformations

34. The diagram below shows a figure and its image.

The image in the above diagram was formed by:

A) a translation.
B) a rotation.
C) a reflection.
D) a reduction.

35. Which of the following illustrates a triangle and its image under a rotation of $\frac{1}{4}$ turn about point P?

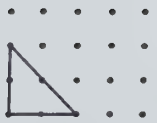
A)

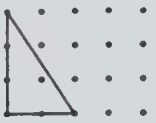
B)

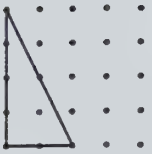
C)

D)

75. Which figure is an enlargement of the original figure by a scale factor of 2?

A) 

B) 

C) 

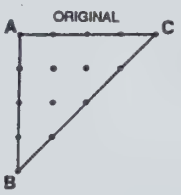
D)

115. The diagram below shows a figure and its image.

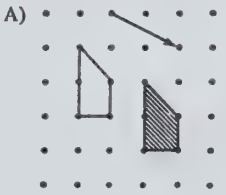
Which of the following describes the above image?

A) enlarged image
B) translated image
C) rotated image
D) reflected image

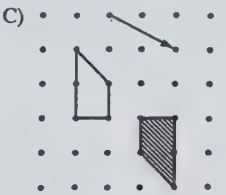
116. Draw on the grid a reduction of triangle ABC. Use a scale factor of 0.5.



152. Which picture below shows the image of a quadrilateral under a given translation shown by the arrow?

A) 

B)

C) 

D)

153. The diagram below shows a figure and its reflected image.

Which diagram below shows the reflection line for the figure and its image?

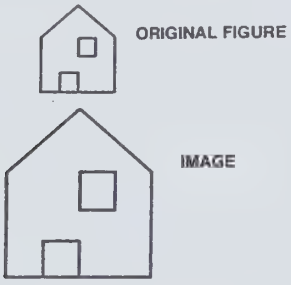
A)

B)

C)

D)

154. The diagram below shows an original figure and its image.



The angles of the image corresponding to the angles of the original figure are:

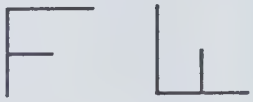
A) greater than those in the original.
B) twice as large as those in the original.
C) less than those in the original.
D) equal to those in the original.

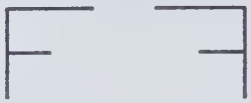
155. The diagram illustrates a figure and its image. Which of the following describes the image?

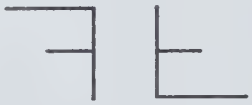
A) rotation image
B) mirror image
C) reflection image
D) translation image

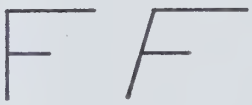
198. In which diagram below is the second figure the image of the first figure under a reflection (flip) line?

A)

B) 

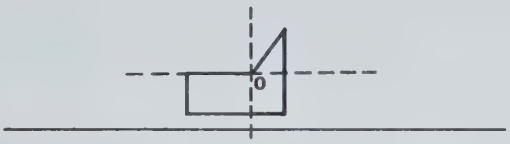
C) 

D) 

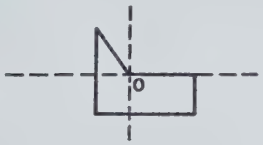
E) 

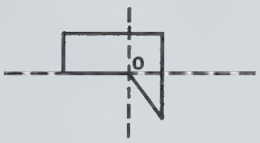
Transformations (cont'd)

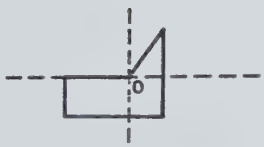
199. A half-turn (180°) about point O is applied to the figure below.

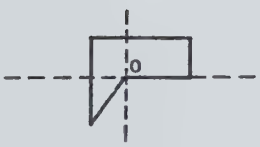


Which of the figures below is the result?

A)


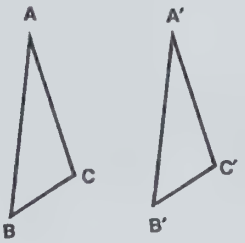
B)


C)


D)


E)

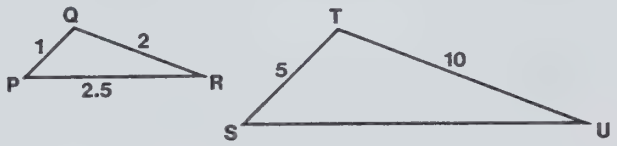
200. △ ABC and △ A′B′C′ are congruent and their corresponding sides are parallel.



△ ABC maps onto △ A′B′C′ by:

A) a reflection
B) a glide reflection (slide flip)
C) a rotation (turn)
D) an enlargement
E) a translation (slide)

187. Triangles PQR and STU are similar.



How long is SU?

A) 5
B) 10
C) 12.5
D) 15
E) 25

189. A model boat is built to scale so that it is $\frac{1}{10}$ as long as the original boat. If the width of the original boat is 4 m, the width of the model should be:

A) 0.1 m
B) 0.4 m
C) 1 m
D) 4 m
E) 40 m

Table D-13
Measurement and Geometry: Transformations

											Panel Rating		
Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Acc*	*Des*	*Rtg*
Comprehension	1-34	(A)	47	18	27	7		1	25	47	70	85	2
	1-35	(C)	10	18	50	20		2	27	50	63	80	2
	2-75	(C)	4	27	57	10		2	39	57	73	85	2
	3-115	(D)	2	12	11	74		2	30	74	76	90	3
	3-116*							14	30	36	70	85	1
	4-152	(A)	40	11	19	28		3	25	40	73	86	1
	4-153	(B)	3	86	5	4		1	29	86	76	89	4
	4-154	(D)	19	30	5	45		1	36	45	71	84	1
	4-155	(A)	62	7	11	19		1	28	62	73	89	3
	5-198	(C)	5	3	80	9	2	1	28	80	73	87	4
	5-199	(D)	13	16	12	51	6	2	23	51	72	85	2
	5-200	(E)	15	9	5	4	66	1	28	66	75	88	3
Application	5-187	(C)	11	11	57	15	5	1	65	57	73	86	2
	5-189	(B)	7	65	8	7	12	1	78	65	72	87	3

*Number of students for question 3-116 is 957.

Process Problems

39. Peter and Juanita decided to start saving money. Peter can save 3 dollars each month and Juanita can save 5 dollars each month. At this rate, after how many months will Juanita have exactly 10 dollars more than Peter?

_____

40. Four students came to a meeting. If each one shook hands with everyone else, how many handshakes would there be altogether?

_____

79. Toothpicks are arranged as follows:

FIGURE 1 FIGURE 2 FIGURE 3

If the pattern is continued, how many toothpicks are used in making the 10th figure?

_____

80. John counted the legs of dogs and children at a dog show in the park. There were a total of 80 legs. If the difference between the number of children and the number of dogs was 1, how many dogs and children were there at the dog show?

_____

119. You have twelve coins totalling $1.65. If your coins are dimes and quarters, how many dimes do you have?

_____

120. A soccer team earns 2 points for a win and 1 point for a tie. The team won twice as many games as it tied and lost no games. If the team scored a total of 15 points, how many games did it play?

_____

159. During the summer, Nina collected white and pink shells on the beach. One day she collected 2 white shells and 1 pink shell. On the next day, she collected 4 white shells and 4 pink shells, and on the third day she found 6 white shells and 7 pink shells. If this pattern continued, on what day did she collect 6 more pink shells than white shells?

_____

160. Tin Jee collects hockey cards. When they are stacked in equal piles of 2 or equal piles of 3, there is 1 left over. However, with piles of 5, there is none left over. If she has fewer than 50 hockey cards, how many cards does she have?

_____

Table D-14
Process Problems

Item	*Key*	*N*	*B*	*C*	*D*	*E*	*F*	*G*	*O*	*OTL*	*Cor*	*Panel Rating* *Acc*	*Des*	*Rtg*
1-39	B+C+D	961	53	2	6	4	5	14	16	88	61	65	80	3
1-40	B+C+D	963	22	1	2	6	12	35	23	73	25	65	80	1
2-79	B+C+D	956	39	2	8	9	7	18	18	67	48	72	83	2
2-80	B+C+D	956	15	2	4	4	5	35	34	73	21	60	75	1
3-119	B+C+D	955	29	3	9	4	8	31	16	82	41	68	81	2
3-120	B+C+D	953	16	2	6	4	7	37	29	80	24	65	78	1
4-159	B+C+D	948	33	1	1	14	9	18	24	77	35	65	83	1
4-160	B+C+D	951	21	2	7	3	5	27	36	76	30	64	78	2

B. Completes the solution correctly, using an appropriate strategy.

C. Gives the correct answer; starts an appropriate strategy, but does not complete it.

D. Gives the correct answer, but does not show reasoning/strategy.

E. Selects an appropriate strategy, but does not get correct answer due to a minor (e.g., computational) error.

F. Selects an appropriate strategy and shows understanding, but does not complete the solution or makes a major error in reasoning.

G. Attempts the question, but does not show understanding that would lead to a solution.

Table D-15
Percentage of Students Using Each Strategy for Process Problems

Item	*A*	*B*	*C*	*D*	*E*	*S*
1-39	20	7	40	14	2	17
1-40	37	9	9	22	4	20
2-79	24	15	13	36	3	10
2-80	49	15	9	5	6	16
3-119	28	20	10	8	17	17
3-120	45	21	8	9	n/a	15
4-159	30	7	57	1	n/a	4
4-160	45	16	11	4	3	21

Strategies Represented by Each Letter

Item	*C*	*D*	*E*
1-39	Organized Table	Arithmetic/Algebraic	Diagram
1-40	Chart or Table	Diagram	Organized List
2-79	Organized Table	Diagram	Algebraic Solution
2-80	Guess and Check	Organized Table	Algebraic Solution or Numerical Calculation
3-119	Organized List	Diagrams or Pictures	Guess and Check
3-120	Organized Table	Guess and Check	n/a
4-159	Organized Table	Diagram or Pictures	n/a
4-160	List	Systematic Elimination	Systematic Trial

Note: A - Did not attempt question, or attempted question but did not show understanding that would lead to a solution

B - Answer only, right or wrong; no work shown

S - Some other strategy shown

Part B: Calculator Questions

51. Calculate $85 \times 3 \times 7 \times 13 \times 37$.

A) 23 205
B) 286 195
C) 858 585
D) 877 455

52. The land areas of Canada's Atlantic Provinces are as follows:

Newfoundland	371 917 km^2
Prince Edward Island	5 678 km^2
Nova Scotia	53 045 km^2
New Brunswick	72 371 km^2

The total land area of Canada's Atlantic Provinces is:

A) 363 011 km^2
B) 503 011 km^2
C) 663 011 km^2
D) 37 193 011 km^2

53. A ticket for a concert costs \$22.75. What is the greatest number of tickets that could be purchased for \$90.00?

A) 2
B) 3
C) 4
D) 5

54. Evaluate $(25.7 \times 36.3) + (4.5 \times 86.2)$.

A) 1 320.81
B) 80 804.742
C) 81 742.152
D) 84 295.842

55. In a skating competition, Judeen had the following scores for her free-style performance in artistic impression:

5.1	5.2	4.8	5.2	5.0	4.9	5.2	5.3

Which question below is best answered using a calculator?

A) What was her highest score?
B) Which score occurred most frequently?
C) What was her average score?
D) How many scores were lower than 5.0?

56. The distance on a map measures 6.4 cm. The actual distance is 2 688 km. On the scale used, 1 cm represents:

A) 42 km
B) 420 km
C) 1 720 km
D) 17 203.2 km

57. A charitable organization hopes to raise \$375 000.00 during a 4-week campaign. The chart shows the results for the first 3 weeks.

WEEK	CONTRIBUTIONS & PLEDGES
FIRST	\$102 029.32
SECOND	\$158 318.68
THIRD	\$ 80 142.75

In order to reach its goal, how much needs to be raised in the 4th week?

A) \$3 450.92
B) \$34 049.08
C) \$34 509.25
D) \$340 490.75

58. Express $4\frac{6}{7}$ as a decimal correct to two decimal places.

A) 2.43
B) 3.86
C) 4.57
D) 4.86

59. A car rental company charges \$39.00 a day plus \$0.18 for each kilometre travelled. For n kilometres per day this would be \$(0.18n + 39). What is the total charge for a one-day trip of 370 km?

A) \$105.60
B) \$409.18
C) \$2 597.40
D) \$14 437.02

60. To the nearest cent, what is 13.5% of \$425?

A) \$5.74
B) \$55.25
C) \$57.38
D) \$573.80

Table D-16
Calculator Questions

Question Number	*Key*	*A*	*B*	*C*	*D*	*O*	*Cor*	*Panel Rating*		
								Acc	*Des*	*Rtg*
51	(C)	0	1	99	0	0	99	85	95	5
52	(B)	1	95	2	2	0	95	85	95	5
53	(B)	1	84	14	1	0	84	82	97	4
54	(A)	68	30	2	1	0	68	72	87	3
55	(C)	4	4	89	2	1	89	81	93	4
56	(B)	7	78	4	10	1	78	77	88	4
57	(C)	4	5	80	10	1	80	77	89	4
58	(D)	5	12	17	64	2	64	80	92	2
59	(A)	73	15	7	5	1	73	75	91	3
60	(C)	8	18	60	12	2	60	78	90	2
61	(B)	7	86	5	1	1	86	80	92	4
62	(D)	6	7	8	77	1	77	77	87	4

Mental-Computation Questions

1. $80 + 35 + 40 =$
2. $560 - 85 =$
3. $720 + 80 =$
4. What is the average of 26, 14, and 20?
5. $3.92 \times 100 =$
6. $6 - 0.75 =$
7. $0.2 \times 0.4 =$
8. $6.5 \div 10 =$
9. How many grams are there in 2.2 kg?
10. $\frac{3}{5}$ of 45 =
11. Express 750 mL in litres.
12. How much change will you receive from $10.00 if you purchase two items which cost $4.75 and $3.50? Disregard the tax.
13. How many centimetres are there in 65 mm?
14. Mary received 30 marks out of a possible 50. What is her mark as a per cent?
15. Guillaume earned $15.00 for 2 hours of work. How much would he earn in 3 hours at the same rate of pay?
16. 25% of 160 =
17. What is the sales tax paid on a $200 purchase if the rate of sales tax is 8%?
18. Jami spent 20% of his money. If he had $50, how much did he spend?
19. How much interest would you earn on $1 000 in one year if the rate per year is 10%?
20. The measures of two angles of a triangle are 50° and 90°. What is the measure of the third angle?

Table D-17
Mental-Computation Questions

Question Number	*Percentage Correct*	*Omit*	*Panel Rating*		
			Acc	*Des*	*Rtg*
1	92	0	80	92	5
2	77	1	75	88	3
3	65	6	78	93	2
4	64	8	74	88	2
5	78	2	81	94	3
6	72	5	75	88	3
7	47	1	76	89	1
8	61	9	79	93	2
9	41	9	75	90	1
10	42	17	75	90	1
11	41	5	77	89	1
12	66	1	73	86	2
13	73	5	76	91	3
14	78	4	82	93	3
15	78	3	75	88	3
16	50	22	74	88	1
17	58	11	77	88	2
18	52	9	76	88	1
19	64	11	80	92	2
20	67	5	78	92	2

Table D-18
Summary of Achievement Data by Topic

Topic	*No. of Items*	*Average Percentage Correct*			*OTL*	*Panel Rating*		
		Female	*Male*	*Total*		*Acc*	*Des*	*Rtg*
Numerical Methods and Algebra	115	65.7	67.6	66.5	88.2	75	88	3
Whole numbers and decimals	15	77.3	76.3	76.7	98.1	78	91	3/4
Factors, powers, and square roots	11	71.9	71.6	71.7	98.1	78	91	3
Fractions	15	58.2	58.4	58.3	97.8	75	88	1
Ratio and rate	13	66.3	71.2	68.6	91.1	72	85	3
Per cent	16	55.7	60.8	58.1	94.4	73	87	2
Integers	15	60.5	63.6	61.9	71.7	75	88	2
Organization and representation of data	14	74.6	78.0	76.2	80.6	76	89	4
Variables, formulas, and equations	16	64.0	63.7	63.8	76.4	72	84	3
Recognition/recall and comprehension	70	65.9	66.9	66.3	89.8	-	-	-
Application	45	65.4	68.6	66.9	85.7	-	-	-
Measurement and Geometry	77	58.9	61.7	60.2	65.7	73	87	3
Measurement	24	57.0	60.2	58.5	83.4	74	87	2
Constructions	14	51.8	53.6	52.6	69.4	74	87	2
Properties of plane figures	15	64.5	66.0	65.2	74.9	74	87	3
Three-dimensional geometry	10	67.7	72.9	70.2	46.8	71	85	4
Transformations	14	57.0	59.7	58.3	35.1	72	86	2/3
Recognition/recall and comprehension	50	58.4	60.5	59.3	59.1	-	-	-
Application	27	59.9	63.9	61.8	77.8	-	-	-
Process Problems	8	35.0	36.4	35.6	77.0	66	80	1
Calculator Questions	12	79.0	80.1	79.6	n/a	79	91	4
Mental-Computation Questions	20	59.4	67.1	63.2	n/a	77	90	2

CONSTRUCTIONS – PART A

EQUIPMENT

ruler, pencil, compasses, paper, transparent mirror

TEACHER DIRECTIONS

Provide the student with the above materials and say:

> **"Using any of the equipment on your desk, construct a 45° angle."**

PLACE A CHECK IN ONE BOX BELOW TO INDICATE WHAT THE STUDENT DID:

- constructed a 45° angle *(proceed to page 2)* ☐1
- did not construct a 45° angle *(proceed to page 4)* ☐2

PLACE A CHECK IN ONE BOX BELOW TO INDICATE WHAT THE STUDENT DID:

- used one of the following methods:
  - paper folding ☐1
  - ruler and compasses ☐2
  - transparent mirror ☐3
- used another strategy *(please describe below)* ☐4

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CONSTRUCTIONS – PART B

TEACHER DIRECTIONS

The teacher says:

> **"Please show me a different method from the one you have just used to construct a 45° angle."**

PLACE A CHECK IN ONE BOX BELOW TO INDICATE WHAT THE STUDENT DID:

- student unable to complete task ☐1
- used one of the following methods:
  - paper folding ☐2
  - ruler and compasses ☐3
  - transparent mirror ☐4
- used another strategy *(please describe below)* ☐5

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CONSTRUCTIONS – PART C

EQUIPMENT

paper, pencil, ruler, compasses, tracing paper

TEACHER DIRECTIONS

Provide the student with the above materials and say:

> **"Using any of the equipment on your desk, construct a triangle with sides of 4 cm, 5 cm, and 6 cm."**

PLACE A CHECK IN ONE BOX BELOW TO INDICATE WHAT THE STUDENT DID:

- constructed the triangle *(proceed to page 5)* ☐1
- did not construct the triangle *(discontinue assessment)* ☐2

PLACE A CHECK IN ONE BOX BELOW TO INDICATE WHAT THE STUDENT DID:

- used one of the following methods:
  - ruler only ☐1
  - ruler and compasses ☐2
- used another strategy *(please describe below)* ☐3

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CIRCLE GRAPH

EQUIPMENT

protractor, compasses, ruler, work paper, calculator, pencil, Question Sheet (provided)

TEACHER DIRECTIONS

Provide the student with the above materials. Place the question sheet in front of the student, but do not read it aloud, and say:

"Read and complete the task described using any of the materials on your desk."

DO NOT READ (*FOR TEACHER'S INFORMATION*)

PROBLEM ON QUESTION SHEET:

Every two weeks, Susie receives money for delivering flyers. She spends her money in the following ways:

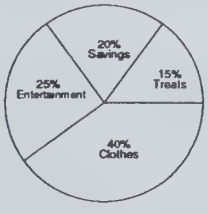
Clothes	40%
Treats	15%
Entertainment	25%
Savings	20%

Construct a circle graph to represent how Susie spends her money. Label your graph.

INDICATE, WITH A CHECK, WHETHER THE STUDENT:

	(1) YES	(2) NO
– drew a circle graph using information provided (*if NO, discontinue assessment*)	☐	☐
– used appropriate labels for the sectors	☐	☐
– titled the graph using an appropriate title e.g., "How Susie Spends Her Money"	☐	☐
– constructed the sectors accurately	☐	☐

EXAMPLE: How Susie Spends Her Money



INDICATE, WITH A CHECK, WHICH STRATEGY THE STUDENT USED TO DRAW THE GRAPH:

- calculated the number of degrees for each item (144°, 54°, 90°, 72°) and used a protractor to draw the graph ☐1
- folded paper to determine angles for the graph ☐2
- estimated the size of the sectors ☐3

TEACHER DIRECTIONS

Attach Question Sheet to Observation Booklet 2.

CALCULATOR – PART A

EQUIPMENT

calculator, piece of paper

TEACHER DIRECTIONS

Provide the student with the above materials and say:

"Enter the number 4035 into your calculator."

PLACE A CHECK IN ONE BOX BELOW TO INDICATE WHAT THE STUDENT DID:	
– was able to enter the given number (*proceed to page 2*)	☐1
– was not able to enter the given number (*discontinue assessment*)	☐2

CALCULATOR – PART B

TEACHER DIRECTIONS

Tell the student:

"I am going to give you a new question. The first number is 1358."

PLACE A CHECK IN ONE BOX BELOW TO INDICATE WHAT THE STUDENT DID:	
– cleared the display before entering the first number	☐1
– did not clear the display before entering the first number	☐2

Clear the display for the student and have the student enter 1358

Then say:

"Add 973 and subtract 236."*

*After the student enters 236, and before the student "hits" the equals sign, say:

"Sorry the number should be 233. What is the total?"

PLACE A CHECK IN ONE BOX BELOW TO INDICATE WHAT THE STUDENT DID:	
– cleared only the last entry	☐1
– cleared all entries and started over	☐2

The teacher may repeat the question, if necessary, as follows:

"Enter 1358. Add 973 and subtract 233. What is the total?"

PLACE A CHECK IN ONE BOX BELOW TO INDICATE WHAT THE STUDENT DID:	
– calculated the correct answer (2098)	☐1
– did not calculate the correct answer	☐2

CALCULATOR – PART C

TEACHER DIRECTIONS

Say to the student:

"Clear your calculator."

Clear the calculator for the student, if necessary. Then say:

"Multiply 33 and 69. What is your answer?"

Note: If the student did not give the correct answer (2277), clear the calculator and enter the correct answer.

Say to the student:

"To this number add the product of 45 and 38."

PLACE A CHECK IN ONE BOX BELOW TO INDICATE WHAT THE STUDENT DID:	
– used the memory keys properly	☐1
– did not use the memory keys properly	☐2

PLACE A CHECK IN ONE BOX BELOW TO INDICATE WHAT THE STUDENT DID:	
– calculated the correct answer (3987)	☐1
– did not calculate the correct answer	☐2

CALCULATOR – PART D

TEACHER DIRECTIONS

Say to the student:

"Clear your calculator."

Clear the calculator for the student, if necessary. Then say:

"Find 15% of 47."

PLACE A CHECK IN ONE BOX BELOW TO INDICATE WHAT THE STUDENT DID:	
– calculated the correct answer (7.05)	☐1
– did not calculate the correct answer	☐2

AREA MEASUREMENT – PART A

EQUIPMENT

- ruler marked in centimetres
- acetate sheet of centimetre squared paper (provided)
- rectangle (provided)

TEACHER DIRECTIONS

Place the rectangle and the acetate of squared paper in front of the student. Keep the ruler out of sight, and say to the student:

"Estimate the area of this figure in square centimetres."

Note: If the student just gives a number without the unit, it is correct.

PLACE A CHECK IN ONE BOX BELOW TO INDICATE WHAT THE STUDENT DID:

- estimated the area within the range of 70 cm^2 – 90 cm^2 ☐1
- estimated the area within the range of 60 cm^2 – 69 cm^2 **OR** 91 cm^2 – 100 cm^2 ☐2
- estimated another area outside the above ranges ☐3

AREA MEASUREMENT – PART B

TEACHER DIRECTIONS

Then say:

"How did you get that area?"

PLACE A CHECK IN ONE BOX BELOW TO INDICATE WHAT THE STUDENT DID:

- used the length of the sides to estimate the area ☐1
- guessed the area ☐2
- used another strategy *(please describe below)* ☐3

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AREA MEASUREMENT – PART C

Give the student the acetate sheet of squared paper, the ruler, and the rectangle to be measured and say:

"Calculate the area of this rectangle in square centimetres."

PLACE A CHECK IN ONE BOX BELOW TO INDICATE WHAT THE STUDENT DID:

- measured the area of the figure as 80 cm^2 ☐1
- did not measure the area of the figure as 80 cm^2 ☐2

PLACE A CHECK IN ONE BOX BELOW TO INDICATE WHAT THE STUDENT DID:

- measured the area of the figure using the ruler and formula ☐1
- measured the area of the figure using the squared acetate ☐2
- measured the area of the figure using another method ☐3 *(please describe below)*

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LENGTH – PART A

EQUIPMENT

- metre stick marked in centimetres
- piece of string 140 cm long (provided)

TEACHER DIRECTIONS

Roll the string into a bundle and place it in front of the student. The metre stick is not to be in sight of the student. Point to the string and say:

"About how many centimetres long is this string?"

Note: If the student uses another unit such as metres or a combination of metres and centimetres, repeat the question:

"About how many centimetres long is this string?"

PLACE A CHECK IN ONE BOX BELOW TO INDICATE WHAT THE STUDENT DID:

- estimated the length in the range of 110 cm – 170 cm ☐1
- estimated the length in the range of 80 cm – 109 cm OR 171 cm – 200 cm ☐2
- estimated the length outside the above ranges ☐3

LENGTH – PART B

TEACHER DIRECTIONS

Then say:

"How did you get the length?"

PLACE A CHECK IN ONE BOX BELOW TO INDICATE WHAT THE STUDENT DID:

- compared the length with a known object's length (e.g., body parts, table top, etc.) ☐1
- guessed the length ("I think it's about...") ☐2
- estimated the length using another strategy ☐3
  (please describe below)

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LENGTH – PART C

TEACHER DIRECTIONS

Give the student the metre stick and say:

"Measure the length of the string in centimetres and tell me the length."

Note: If the student uses another unit such as metres, or a combination of metres and centimetres, repeat the question:

"Measure the length of the string in centimetres."

PLACE A CHECK IN ONE BOX BELOW TO INDICATE WHAT THE STUDENT DID:

- measured the length of the string in the range 135 cm – 145 cm ☐1
- measured the length of the string outside the range given above ☐2

ESTIMATION – PART A

EQUIPMENT

- timing device that shows seconds
- sheet of circles (provided)

TEACHER DIRECTIONS

Do not show the page of circles until the student is ready to begin. The page is to be removed from sight at the end of the 15–second time limit.

Before presenting the page to the student, say:

> **"Before I start the activity, I will show you how long 15 seconds lasts."**

Start the watch and say:

> **"Time begins."**

At the end of 15 seconds, say:

> **"That was 15 seconds. I will show you a page of circles for 15 seconds. At the end of 15 seconds, you are to tell me about how many circles are on the whole page."**

Place the sheet in front of the student and start to time 15 seconds. At the end of 15 seconds, move the page out of sight and say:

> **"Stop! How many circles do you think are on the page?"**

Do not accept "I don't know" as a response.

PLACE A CHECK IN ONE BOX BELOW TO INDICATE WHAT THE STUDENT DID:

- estimated the number of circles in the range 70 – 90 ☐1
- estimated the number of circles in the range 60 – 69 **OR** 91 – 100 ☐2
- estimated the number of circles in the range 50 – 59 **OR** 101 – 110 ☐3
- estimated some other number ☐4

ESTIMATION – PART B

TEACHER DIRECTIONS

Show the student the paper again and say:

> **"How did you get that number?"**

PLACE A CHECK IN ONE BOX BELOW TO INDICATE WHAT THE STUDENT DID:

- counted the number of rows and columns and multiplied ☐1
- counted the number of circles in one-half the page and then doubled ☐2
- counted the number of circles in one-quarter of of the page and then multiplied by 4 ☐3
- counted the circles until time was up and then estimated the number of remaining circles to get an estimated total ☐4
- guessed the number by inspection ("I just guessed") ☐5
- used another method to find the number *(please describe below)* ☐6

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Table D-19
Item Statistics: Observation Booklets

Task		Observations Marked * 1st	2nd	3rd	4th	5th	6th	7th	8th	9th	Omit
Booklet 1	***Constructing a 45° Angle***										
1A	Constructing the angle	68.6	30.7	-	-	-	-	-	-	-	0.7
1A	Method used to construct the angle	4.2	46.4	7.4	0	0.2	2.9	2.0	2.2	2.2	32.4
1B	Constructing the angle using a different method	19.9	17.0	10.3	11.5	0	1.0	2.2	3.4	1.7	32.9
1C	Constructing a triangle	82.1	13.3	-	-	-	-	-	-	-	4.7
1C	Method used to construct the triangle	51.8	32.7	0	0.2	-	-	-	-	0	15.2
Booklet 2	***Constructing a Circle Graph***										
2A	Parts of the circle graph										
	• Draw a circle graph using information provided	88.4	10.4	-	-	-	-	-	-	-	1.2
	• Used appropriate labels for the sectors	80.9	8.7	-	-	-	-	-	-	-	10.4
	• Used an appropriate title for the graph	34.4	54.2	-	-	-	-	-	-	-	11.4
	• Constructed the sectors accurately	52.5	35.4	-	-	-	-	-	-	-	12.1
2B	Strategy used to draw graph	55.0	0	32.2	-	-	-	-	-	-	12.9
Booklet 3	***Using a Calculator***										
3A	Entering a number into the calculator	98.0	0.7	-	-	-	-	-	-	-	1.2
3B	Clearing the display	95.1	3.2	-	-	-	-	-	-	-	1.7
3B	Correcting an entry	44.2	41.3	-	-	-	-	-	-	-	14.5
3B	Calculating the answer [addition and subtraction]	81.6	16.7	-	-	-	-	-	-	-	1.7
3C	Using memory keys	21.1	74.4	-	-	-	-	-	-	-	4.4
3C	Calculating the answer [multiplication]	34.2	65.1	-	-	-	-	-	-	-	0.7
3D	Calculating the answer [per cent]	53.1	39.8	-	-	-	-	-	-	-	7.1
Booklet 4	***Area of a Rectangle***										
4A	Estimating the area of the rectangle	61.7	10.4	27.7	-	-	-	-	-	-	0.2
4B	Method used to estimate the area	70.9	17.8	0	10.1	0.2	-	-	-	-	1.0
4C	Measuring the area of the rectangle	87.4	12.1	-	-	-	-	-	-	-	0.5
4C	Method used to measure the area	63.5	32.3	0	2.7	-	-	-	-	-	1.5
Booklet 5	***String Length***										
5A	Estimating length	39.5	42.5	17.5	-	-	-	-	-	-	0.5
5B	Estimation method	55.8	42.5	0	0.5	-	-	-	-	-	1.2
5C	Measuring length	91.9	7.2	-	-	-	-	-	-	-	1.0
Booklet 6	***Counting Circles***										
6A	Estimating number of circles	42.6	30.4	16.8	10.1	-	-	-	-	-	0
6B	Estimation method	9.2	23.3	9.9	35.6	10.9	0	8.9	1.2	-	1.0

* The descriptions of student behaviours that correspond to the "observations marked" are provided on the following pages.

Descriptions of Student Behaviours for Observation Booklets

Booklet 1 ***Constructing a 45° Angle***

1A Constructing the angle
- 1st (constructed the 45° angle)
- 2nd (did not construct the 45° angle)

1A Method used to construct the angle
- 1st (paper folding)
- 2nd (ruler and compasses)
- 3rd (transparent mirror)
- 4th (used another strategy)
- ☛ 5th (combination of transparent mirror and folding)
- ☛ 6th (estimated using a ruler)
- ☛ 7th (estimated and drew free-hand)
- ☛ 8th (used a circle, square, or triangle)
- ☛ 9th (other)

1B Constructing the angle using a different method
- 1st (unable to complete task)
- 2nd (paper folding)
- 3rd (ruler and compasses)
- 4th (transparent mirror)
- 5th (used another strategy)
- ☛ 6th (estimated and drew free-hand)
- ☛ 7th (estimated using a ruler)
- ☛ 8th (used a circle, square, or triangle)
- ☛ 9th (other)

1C Constructing a triangle
- 1st (constructed the triangle)
- 2nd (did not construct the triangle)

1C Method used to construct the triangle
- 1st (ruler only)
- 2nd (ruler and compasses)
- 3rd (used another strategy)
- ☛ 4th (ruler and corner of paper)
- 9th (other)

Booklet 2 ***Constructing a Circle Graph***

2A Parts of the circle graph

Drew a circle graph using information provided
- 1st (yes)
- 2nd (no)

Used appropriate labels for the sectors
- 1st (yes)
- 2nd (no)

Used an appropriate title for the graph
- 1st (yes)
- 2nd (no)

Constructed the sectors accurately
- 1st (yes)
- 2nd (no)

2B Strategy used to draw graph
- 1st (calculated number of degrees for each item and used protractor to draw graph)
- 2nd (folded paper to determine angles for the graph)
- 3rd (estimated the size of the sectors)

Descriptions of Student Behaviours for Observation Booklets (cont'd)

Booklet 3 ***Using a Calculator***

3A Entering a number into the calculator
- 1st (able to enter the given number)
- 2nd (not able to enter the given number)

3B Clearing the display
- 1st (clearing the display before entering the first number)
- 2nd (did not clear the display before entering the first number)

3B Correcting an entry
- 1st (cleared only the last entry)
- 2nd (cleared all entries and started over)

3B Calculating the answer [addition and subtraction]
- 1st (calculated the correct answer)
- 2nd (did not calculate the correct answer)

3C Using memory keys
- 1st (used the memory keys properly)
- 2nd (did not use the memory keys properly)

3C Calculating the answer [multiplication]
- 1st (calculated the correct answer)
- 2nd (did not calculate the correct answer)

3D Calculating the answer [per cent]
- 1st (calculated the correct answer)
- 2nd (did not calculate the correct answer)

Booklet 4 ***Area of a Rectangle***

4A Estimating the area of the rectangle
- 1st (estimated the area within the range of 70 cm^2 - 90 cm^2)
- 2nd (estimated the area within the range of 60 cm^2 - 69 cm^2 or 91 cm^2 - 100 cm^2)
- 3rd (estimated another area outside the above ranges)

4B Method used to estimate the area
- 1st (used the length of the sides to estimate the area)
- 2nd (guessed the area)
- 3rd (used another strategy)
- ☛ 4th (used acetate sheet)
- ☛ 5th (other)

4C Measuring the area of the rectangle
- 1st (measured the area of the figure as 80 cm^2)
- 2nd (did not measure the area of the figure as 80 cm^2)

4C Method used to measure the area
- 1st (used ruler and formula)
- 2nd (used squared acetate)
- 3rd (used another strategy)
- ☛ 4th (other)

Descriptions of Student Behaviours for Observation Booklets (cont'd)

Booklet 5 ***String Length***

5A Estimating length
- 1st (estimated length in the range of 110 cm - 170 cm)
- 2nd (estimated length in the range of 80 cm - 109 cm or 171 cm - 200 cm)
- 3rd (estimated the length outside the above ranges)

5B Estimation method
- 1st (compared the length with a known object's length)
- 2nd (guessed the length)
- 3rd (estimated the length using another strategy)
- 4th (other)

5C Measuring length
- 1st (measured the length in the range of 135 cm - 145 cm)
- 2nd (measured the length outside the above ranges)

Booklet 6 ***Counting Circles***

6A Estimating number of circles
- 1st (estimated number of circles in the range of 70-90)
- 2nd (estimated number of circles in the range of 60-69 or 91-100)
- 3rd (estimated number of circles in the range of 50-59 or 101-110)
- 4th (estimated some other number)

6B Estimation method
- 1st (counted number of rows and columns, then multiplied)
- 2nd (counted number of circles in one-half the page, then doubled)
- 3rd (counted number of circles in one-quarter the page, then multiplied by 4)
- 4th (counted number of circles until time was up, then estimated number of remaining circles to get estimated total)
- 5th (guessed number by inspection)
- 6th (used another appropriate strategy to find the number)
- ☛ 7th (grouped circles or counted by groups)
- ☛ 8th (other)

When teachers coded "used another strategy" they provided a description of that strategy. These descriptions were classified into categories marked by ☛. In Table D-19, a **0** has been recorded for "used another strategy" because these responses are reported in the newly created categories.

Table D-20
Teacher Responses for Opportunity to Learn

Percentage of Teachers

			Reasons for Not Teaching			
	Question Number	*Taught*	*Taught prior*	*Taught later*	*Not in curriculum*	*Other reasons*
Numerical Methods and Algebra	1-1	98	2	0	0	0
	1-2	99	1	0	0	0
	1-3	99	1	0	0	0
	1-4	95	1	3	0	1
	1-5	96	2	2	0	1
	1-6	95	4	1	0	1
	1-7	95	4	2	0	0
	1-8	98	1	0	0	1
	1-9	93	1	5	0	1
	1-10	93	1	5	0	2
	1-11	92	1	6	0	2
	1-12	96	1	3	0	1
	1-13	97	1	3	0	0
	1-14	89	1	9	0	2
	1-15	92	1	7	0	1
	1-16	75	2	22	0	2
	1-17	76	2	22	0	1
	1-18	74	2	23	0	1
	1-19	76	13	6	2	4
	1-20	77	13	6	0	4
	1-21	76	12	8	0	3
	1-22	74	3	20	1	2
	1-23	71	2	20	2	5
	1-24	71	3	22	2	3
	2-41	97	3	0	0	1
	2-42	92	8	0	0	1
	2-43	95	5	0	0	0
	2-44	94	5	0	0	2
	2-45	99	0	1	0	0
	2-46	94	3	2	1	1
	2-47	96	2	2	0	0
	2-48	97	2	1	0	1
	2-49	83	3	7	1	6
	2-50	88	1	5	0	6
	2-51	94	3	1	0	2
	2-52	91	1	6	0	2
	2-53	95	0	3	0	2
	2-54	95	1	3	0	2
	2-55	76	2	21	0	2

Table D-20 (cont'd)
Teacher Responses for Opportunity to Learn

Percentage of Teachers

			Reasons for Not Teaching			
	Question Number	*Taught*	*Taught prior*	*Taught later*	*Not in curriculum*	*Other reasons*
Numerical Methods and Algebra (continued)	2-56	73	2	25	0	1
	2-57	51	6	33	3	8
	2-58	76	11	8	0	5
	2-59	73	10	9	0	7
	2-60	62	5	20	0	13
	2-61	77	1	20	1	1
	2-62	73	1	22	2	2
	2-63	73	1	23	2	2
	3-81	96	4	0	0	0
	3-82	97	2	1	0	1
	3-83	95	4	0	1	1
	3-84	93	2	2	1	3
	3-85	97	3	1	0	0
	3-86	95	3	1	0	1
	3-87	95	1	3	0	1
	3-88	94	2	2	0	2
	3-89	92	1	4	0	3
	3-90	95	0	3	0	2
	3-91	92	0	4	0	4
	3-92	94	1	3	0	3
	3-93	98	0	1	0	1
	3-94	92	1	6	0	2
	3-95	75	3	22	0	1
	3-96	51	5	33	2	10
	3-97	72	2	24	0	2
	3-98	73	8	12	1	6
	3-99	71	14	7	2	6
	3-100	73	6	12	1	8
	3-101	81	3	15	1	1
	3-102	68	2	21	3	5
	3-103	80	3	13	1	4
	3-118	92	3	3	1	2
	4-121	98	1	1	0	0
	4-122	97	3	0	0	1
	4-123	93	7	0	0	0
	4-124	98	1	1	0	1
	4-125	94	5	1	0	0
	4-126	99	1	0	0	0
	4-127	95	3	2	0	1

Table D-20 (cont'd)
Teacher Responses for Opportunity to Learn

Percentage of Teachers

			Reasons for Not Teaching			
	Question Number	*Taught*	*Taught prior*	*Taught later*	*Not in curriculum*	*Other reasons*
Numerical Methods and Algebra (continued)	4-128	96	3	2	0	0
	4-129	98	1	1	0	1
	4-130	93	0	5	0	2
	4-131	69	3	11	3	13
	4-132	94	1	4	0	1
	4-133	97	0	2	0	1
	4-134	93	0	5	0	2
	4-135	89	1	7	0	3
	4-136	76	2	21	0	1
	4-137	78	3	19	0	1
	4-138	76	2	20	0	2
	4-139	64	10	13	1	11
	4-140	73	12	8	0	8
	4-141	63	4	16	2	15
	4-142	84	1	14	1	1
	4-143	79	2	16	1	3
	4-144	77	1	20	1	1
	5-161	98	2	0	0	1
	5-162	97	3	0	0	0
	5-163	97	2	1	0	1
	5-164	99	0	1	0	0
	5-165	95	0	3	0	2
	5-166	97	2	1	0	0
	5-167	98	2	1	0	0
	5-168	94	4	1	1	1
	5-169	94	0	4	0	2
	5-170	92	1	4	0	4
	5-171	80	2	16	1	1
	5-172	76	1	20	2	2
	5-173	76	0	19	1	4
	5-190	68	8	13	3	9
	5-191	50	5	32	2	10
	5-192	77	3	10	2	8
	5-193	79	3	17	1	0
	5-194	56	3	27	4	10
	5-195	72	6	12	1	10
	5-196	58	1	21	7	13

Table D-20 (cont'd)
Teacher Responses for Opportunity to Learn

Percentage of Teachers

	Question Number	*Taught*	*Reasons for Not Teaching*			
			Taught prior	*Taught later*	*Not in curriculum*	*Other reasons*
Measurement and Geometry	1-25	84	2	13	0	2
	1-26	85	3	11	0	1
	1-27	83	1	13	1	3
	1-28	82	12	4	0	3
	1-29	66	3	26	0	6
	1-30	68	4	26	0	3
	1-31	78	3	16	0	3
	1-32	44	6	30	3	16
	1-33	36	6	30	5	22
	1-34	21	5	55	2	18
	1-35	21	6	53	2	18
	1-36	64	4	28	0	4
	1-37	66	5	25	1	4
	1-38	64	5	26	1	4
	2-64	77	1	15	0	7
	2-65	90	5	4	0	1
	2-66	88	9	1	0	2
	2-67	84	3	9	0	5
	2-68	73	5	19	0	3
	2-69	71	4	19	1	5
	2-70	81	6	12	0	2
	2-71	51	2	31	2	16
	2-72	71	7	18	0	4
	2-73	42	9	31	2	16
	2-74	62	4	30	0	5
	2-75	34	5	40	1	20
	2-76	52	3	37	1	8
	2-77	62	5	27	0	7
	2-78	36	6	31	4	22
	3-104	87	6	6	1	1
	3-105	58	1	27	1	14
	3-106	73	7	17	1	3
	3-107	83	4	9	0	4
	3-108	75	7	16	1	2
	3-109	64	5	26	0	5
	3-110	72	4	18	1	5
	3-111	73	4	20	1	3
	3-112	77	5	14	1	3

Table D-20 (cont'd)
Teacher Responses for Opportunity to Learn

Percentage of Teachers

			Reasons for Not Teaching			
	Question Number	*Taught*	*Taught prior*	*Taught later*	*Not in curriculum*	*Other reasons*
Measurement and Geometry (continued)	3-113	57	4	27	2	10
	3-114	38	6	32	3	22
	3-115	25	5	50	2	19
	3-116	27	4	45	2	24
	3-117	46	5	28	3	18
	4-145	86	4	10	0	1
	4-146	70	3	19	1	7
	4-147	48	2	29	5	15
	4-148	89	4	5	1	1
	4-149	76	4	16	1	3
	4-150	70	4	17	2	7
	4-151	43	5	20	7	25
	4-152	20	5	55	1	19
	4-153	23	5	53	1	18
	4-154	33	3	42	1	21
	4-155	22	6	55	1	17
	4-156	61	5	30	0	5
	4-157	60	3	30	0	8
	4-158	44	7	28	3	18
	5-174	92	7	1	0	1
	5-175	88	8	1	1	2
	5-176	59	6	13	3	19
	5-177	72	5	19	1	5
	5-178	82	1	13	0	5
	5-179	84	1	12	0	3
	5-180	82	1	11	1	6
	5-181	66	3	19	2	10
	5-182	81	6	11	1	2
	5-183	74	3	19	0	3
	5-184	69	4	22	1	5
	5-185	73	4	17	1	5
	5-186	75	5	16	0	4
	5-187	61	4	21	1	13
	5-188	34	4	26	9	27
	5-189	78	1	12	2	8
	5-197	44	7	23	6	21
	5-198	24	5	51	2	19
	5-199	18	5	55	3	19
	5-200	22	6	50	1	21

Table D-20 (cont'd)
Teacher Responses for Opportunity to Learn

Percentage of Teachers

			Reasons for Not Teaching			
	Question Number	*Taught*	*Taught prior*	*Taught later*	*Not in curriculum*	*Other reasons*
Process	1-39	88	1	6	0	6
Problems	1-40	72	1	13	3	12
	2-79	61	6	9	5	20
	2-80	71	2	9	4	13
	3-119	78	4	7	3	9
	3-120	77	3	9	3	8
	4-159	75	2	7	3	13
	4-160	74	2	6	4	15

Appendix E: Confidence Intervals for Achievement Results

This review used a matrix sampling of students and test questions. Questions were divided into five assessment booklets and each student participating in the review responded to only one booklet. Since each student did not answer all questions, there is a degree of uncertainty associated with the achievement results reported in Appendix D. The estimates from matrix samples are generally good for scores that sum across the matrix samples – that is, that include questions from each booklet and therefore include information about all students. The statistical accuracy of an estimated response rate for a single item is, on the other hand, relatively low, since the item is answered by only one-fifth of the students.

The magnitude of the uncertainty for each curriculum area and for individual items is given in Table E-1 in the form of the 95 per cent confidence-band widths. For example, the band width for numerical methods and algebra is ±0.5 per cent and the average percentage correct as reported in Table D-18 is 66.5. The confidence interval for this topic is 66.5 per cent plus or minus 0.5 per cent, or 66.0 to 67.0 per cent. The average percentage correct would fall within this range 95 times out of 100 if the review were repeated with similar sampling procedures.

The band width for an individual item depends on the percentage correct. For example, an item answered correctly by 53 per cent of students has a band width of ±3.2 per cent. The confidence interval for the item is 53 per cent plus or minus 3.2 per cent.

Since all students participating in the review answered all the Calculator Questions and the Mental-Computation Questions, there is no sampling error associated with the results for these questions.

The confidence-band widths for each curriculum area for the averages for female and male students are given in Table E-2. Results for individual questions were not reported by gender.

Table E-1
Confidence-Band Widths for Achievement Topics and Individual Items

Confidence-band Width (±%)	*Topic*
0.5	*Numerical Methods and Algebra*
0.8	Whole numbers and decimals
0.9	Factors, powers, and square roots
1.0	Fractions and decimals
0.9	Ratio and rate
0.9	Per cent
0.8	Integers
0.7	Organization and representation of data
0.9	Variables, formulas, and equations
0.6	Recognition/recall and comprehension
0.6	Application
0.6	*Measurement and Geometry*
0.7	Measurement
1.1	Constructions
0.9	Properties of plane figures
0.9	Three-dimensional geometry
0.9	Transformations
0.7	Recognition/recall and comprehension
0.7	Application
1.2	*Process Problems*

Confidence-band Width (±%)	*Individual Item*
1.9	Individual item with 10% correct response
2.6	Individual item with 20% correct response
2.9	Individual item with 30% correct response
3.1	Individual item with 40% correct response
3.2	Individual item with 50% correct response
3.1	Individual item with 60% correct response
2.9	Individual item with 70% correct response
2.6	Individual item with 80% correct response
1.9	Individual item with 90% correct response

Table E-2
Confidence-Band Widths for Achievement Topics by Gender

Confidence-band Width (±%)		*Topic*
Females	*Males*	
0.7	0.8	*Numerical Methods and Algebra*
1.1	1.1	Whole numbers and decimals
1.2	1.3	Factors, powers, and square roots
1.4	1.4	Fractions and decimals
1.2	1.2	Ratio and rate
1.2	1.3	Per cent
1.1	1.2	Integers
1.0	1.1	Organization and representation of data
1.3	1.3	Variables, formulas, and equations
0.8	0.8	Recognition/recall and comprehension
0.8	0.9	Application
0.8	0.9	*Measurement and Geometry*
1.0	1.0	Measurement
1.5	1.5	Constructions
1.3	1.3	Properties of plane figures
1.3	1.3	Three-dimensional geometry
1.3	1.4	Transformations
0.9	1.0	Recognition/recall and comprehension
1.0	1.0	Application
1.7	1.7	*Process Problems*

Appendix F: Analysis of Planning Documents

Type of Document

1. Number of school-level documents: 50
2. Number of board-level documents: 29

The numbers in this appendix specify the percentage of documents that met specified criteria. One set of percentages is given for the 50 school-level documents that were submitted and one set of percentages is given for the 29 board-level documents.

	School		Board	
Course Guideline	**Yes %**	**No**	**Yes %**	**No**
3. Was the appropriate guideline identified (*Curriculum Guideline Mathematics Intermediate and Senior Divisions, 1985, Part Two or Part Three: Grades 7 and 8*)?	33	67	60	40
4. Did the document include a general description of the course?	24	76	68	32

Content Area		Objectives Listed: School Yes %	School No	Board Yes %	Board No
5. Were the following content objectives listed and did they state a time requirement consistent with the guidelines indicated in the brochure?					
Numerical Methods and Algebra:	*Suggested Hours*				
• Calculator skills	(2)	60	40	74	26
• Whole numbers and decimals	(8)	100	0	100	0
• Factors, powers, and square roots	(6)	92	8	100	0
• Fractions and decimals	(7)	100	0	100	0
• Ratio and rate	(8)	100	0	96	4
• Per cent	(8)	98	2	100	0
• Integers	(7)	94	6	100	0
• Organization and representation of data	(7)	88	12	100	0
• Variables, formulas, and equations	(9)	96	4	96	4
• Relations	(optional)	40	60	59	41
• Mathematics and the computer	(optional)	22	78	58	42
• Probability	(optional)	27	73	56	44
Measurement and Geometry:					
• Measurement	(11)	98	2	100	0
• Constructions	(10)	94	6	96	4
• Properties of plane figures	(6)	90	10	93	7
• Three-dimensional geometry	(5)	85	15	100	0
• Transformations	(6)	96	4	96	4
Core extension or options	(20)	3	97	38	62
Minimum total time requirement	(120)				

Content Area		Minimum Time Requirement Met			
		School		Board	
		Yes %	No	Yes %	No
5. Were the following content objectives listed and did they state a time requirement consistent with the guidelines indicated in the brochure?					
Numerical Methods and Algebra:	*Suggested Hours*				
• Calculator skills	(2)	43	57	56	44
• Whole numbers and decimals	(8)	61	39	64	36
• Factors, powers, and square roots	(6)	56	44	64	36
• Fractions and decimals	(7)	59	41	64	36
• Ratio and rate	(8)	61	39	60	40
• Per cent	(8)	58	42	64	36
• Integers	(7)	58	42	62	38
• Organization and representation of data	(7)	61	39	62	38
• Variables, formulas, and equations	(9)	58	42	58	42
• Relations	(optional)	23	77	30	70
• Mathematics and the computer	(optional)	17	83	37	63
• Probability	(optional)	21	79	32	68
Measurement and Geometry:					
• Measurement	(11)	61	39	62	38
• Constructions	(10)	63	37	54	46
• Properties of plane figures	(6)	55	45	58	42
• Three-dimensional geometry	(5)	52	48	56	44
• Transformations	(6)	55	45	55	45
Minimum total time requirement	(120)				

Content Area (cont'd)	School Yes %	School No	Board Yes %	Board No
6. Did the document address the following process components?				
• Experiential approach	18	82	52	48
• Proof	8	92	21	79
• Problem Solving	47	53	69	31
7. Was there an indication of a scope and sequence or program delivery chart?	50	50	69	31

Course Objectives	School Yes %	School No	Board Yes %	Board No
8. Was a rationale/statement of philosophy outlined?	14	86	62	38
9. Were general course aims included?	38	62	61	39
10. Were objectives included for each content area?	38	62	96	4
11. Were the following types of objectives included?				
(a) Attitudes	4	96	29	71
(b) Skills	41	59	93	7
(c) Knowledge	41	59	93	7
12. Were the following objectives mainly stated in terms of students' learning outcomes for the following?				
(a) Attitudes	4	96	21	79
(b) Skills	39	61	93	7
(c) Knowledge	39	61	93	7

Teaching Methods	School Yes %	School No	Board Yes %	Board No
13. Did the documents include a multi-resource approach to mathematics?	10	90	54	46
14. Were possible instructional methods or teaching strategies described?	18	82	57	43
15. Were sample activities, lesson plans, tasks, or problems provided?	6	94	46	54
16. Was the specific use of calculators indicated?	27	73	68	32
17. Was the specific use of computers indicated?	18	82	39	61
18. Did the teaching strategies include the use of mathematics equipment?	10	90	46	54

Evaluation Practices	School Yes %	School No	Board Yes %	Board No
19. Were theoretical or background statements about assessment/evaluation included?	27	73	61	39
20. Were evaluation practices described?	27	73	50	50
21. Were the following procedures included?				
• Formative evaluation	34	66	54	46
— records of previous achievement	2	98	25	75
— topic or unit pretests (ranging from informal oral questioning to written diagnostic tests)	29	71	39	61
— systematic observations of attitudes and performance, including oral and written presentations of solutions to problems	43	57	46	54
— informal questioning related to specific objectives	19	81	33	67
— teacher-student discussions or interviews	23	77	46	54
— self-evaluation by students	15	85	25	75
— peer evaluation by students	13	87	11	89

Evaluation Practices (cont'd)	School Yes %	School No	Board Yes %	Board No
• Summative evaluation	43	57	61	39
— topic or unit post-tests	55	45	57	43
— formal examinations at specific intervals	100		21	79
— standardized tests related to course objectives	4	6	25	75
— projects or essays	25	75	29	71
22. Was the relative emphasis/weight of evaluation components for student marks/grades outlined?	27	73	25	75
23. Was information on reporting to parents outlined?	2	98	14	86

Resources	School Yes %	School No	Board Yes %	Board No
24. Was a textbook or other learning materials indicated?	52	48	61	39
25. Was a list of reference books or other professional materials for use by teachers provided?	38	62	54	46
26. Was the use of concrete manipulative aids outlined?	12	88	46	54

Appendix G: Committee Members

This appendix lists members of the following committees: item development, marking of screening materials, marking reliability, interpretation panel, and planning documents analysis. All committees had both English-speaking and French-speaking members and were divided into English and French subcommittees to deal with issues specific to each language. General issues that applied to the reviews in both languages were discussed by all members of a given committee.

Ministry of Education personnel were responsible for directing the various activities for the committees and for providing in-service for the board contacts and support for schools and boards involved in the review.

Ministry of Education

Agnès Bénéteau	Région de l'ouest de l'Ontario
George Blackwood, Ph.D.	Learning Assessment Branch
Michel Broschart	Centre de l'éducation de la petite enfance et de l'enseignement élémentaire
Dana D'Amore	Learning Assessment Branch
Michael Kozlow, Ph.D.	Learning Assessment Branch
Jacinthe Leclerc	Direction de l'évaluation de l'apprentissage
Robert Morrow	Learning Assessment Branch
Roger Perreault	Région du nord-est de l'Ontario
Dennis Raphael, Ph.D.	Learning Assessment Branch
Robert Robinson	Centre for Early Childhood and Elementary Education
Bert Stahlke	Centre for Early Childhood and Elementary Education
Marilyn Sullivan	Learning Assessment Branch
André Vézina	Direction de l'évaluation de l'apprentissage
André Vinette	Région de l'est de l'Ontario
Woilford Whissell	Région du centre-nord de l'Ontario
Dale Willoughby	Northwestern Ontario Region
Dennis Yapps	Direction de l'évaluation de l'apprentissage
Denis Yelle	Direction des programmes d'enseignement

Item Development Team

Sheila Chalat	Lakehead Board of Education
Elizabeth Jarrell	Durham Region Roman Catholic Separate School Board
Raynald Lacasse	Faculté d'éducation, Université d'Ottawa
Paul Lessard	Hamilton (Ontario)
Agnes Rhuland	City of York Board of Education
Paul Zolis	Scarborough Board of Education

Marking of Screening Materials

Ann Pearce	Oxford County Board of Education
Susan Stuart	Sudbury Board of Education
Harry Traini	Hamilton Board of Education
Lorna Wiggan	Faculty of Education York University

Marking Reliability Committee

Warren Edwards	Wentworth County Board of Education
Clara Simpson	Niagara South Board of Education

Planning Documents Analysis Committee

George Knill	Hamilton Board of Education
Brian Macartney	Haldimand Board of Education
Pierrette Macintosh	Welland County Roman Catholic Separate School Board
Harry Triani	Hamilton Board of Education

Interpretation Panel

English

Mary Challoner Parent	Whitby (Ontario)
Jim Harlock Teacher	Perth County Board of Education
William Higginson, Ph.D. Professor	Faculty of Education Queen's University
Roland Morrow, Ph.D. Principal [OAME]	Frontenac County Board of Education
Alexander Norrie, Ph.D. Consultant [OMCA]	Peel Board of Education
Harold Peters Teacher [OSSTF]	Northumberland & Newcastle Board of Education
Stan Polowski Teacher	Hornepayne Board of Education
Margaret Sawicka Teacher	Ottawa Roman Catholic Separate School Board
Patrick Smith Parent [FCP-TAO]	London (Ontario)
Linda Strey Parent/Teacher	Lakehead Board of Education
Margaret Surtees Teacher/Math Consultant	Nipissing District Roman Catholic Separate School Board

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